# METALS and ALLOYS

The Engineering Magazine of the Metal Industries

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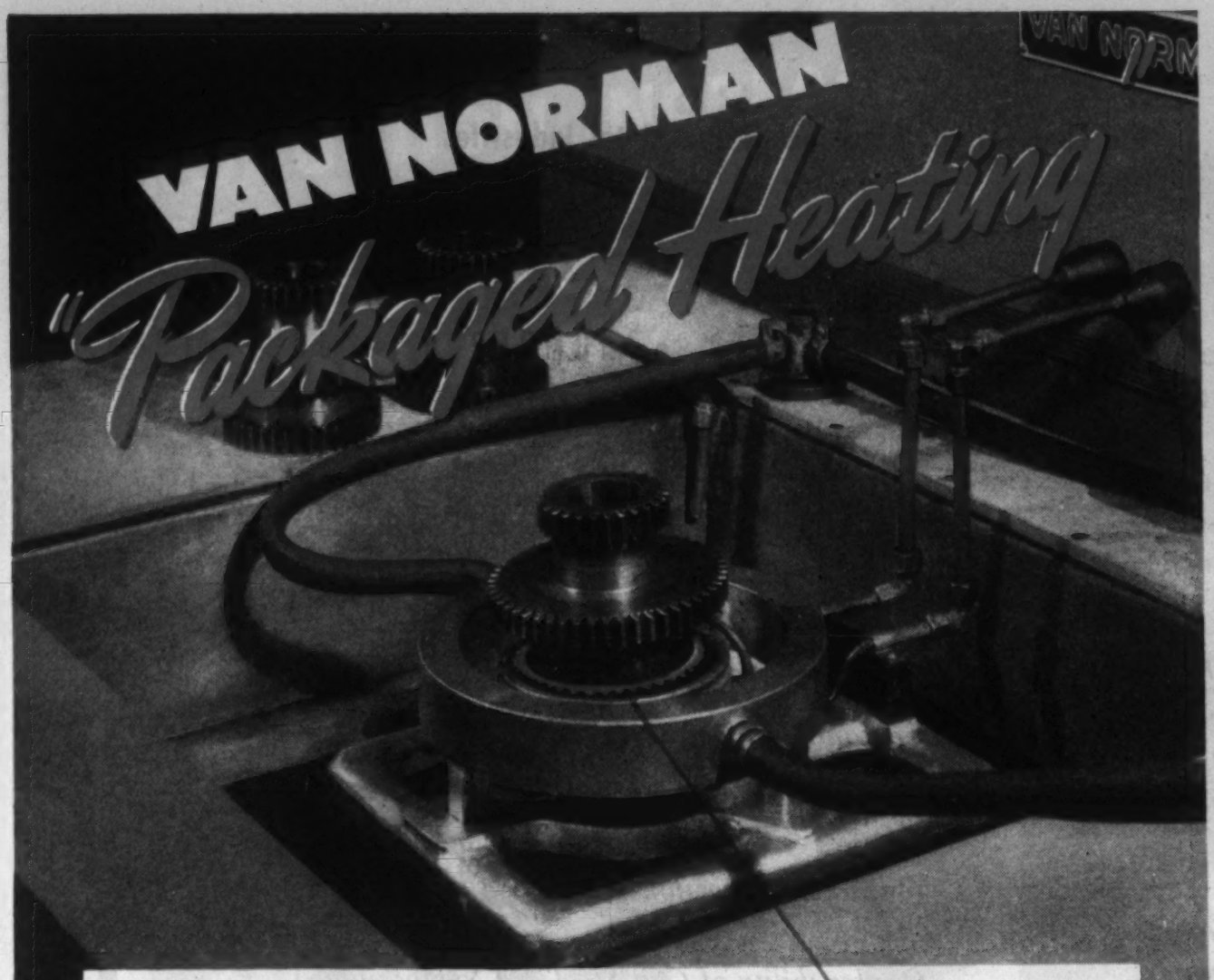
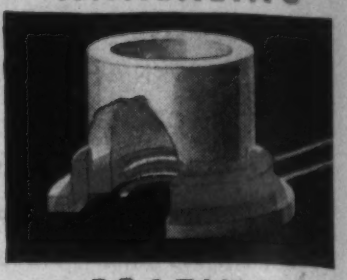
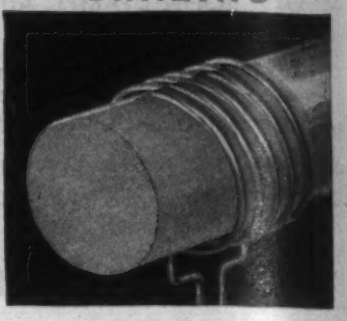



A Van Norman Packaged Heating setup for surface hardening a gear section of a triple-cluster gear. The gear teeth are hardened to 55-57 Rockwell C in 20 seconds which includes 13 seconds heating and 7 seconds for quenching. Depth of heat penetration is .035" to .045". The teeth of the small gear section as well as the larger middle gear section are also hardened to 55-57 Rockwell C. Small gear is hardened in 16 seconds — 10 seconds for heat and 6 seconds for quench. The large gear is hardened in 25 seconds — 17 seconds for heat followed by an 8 second quench.

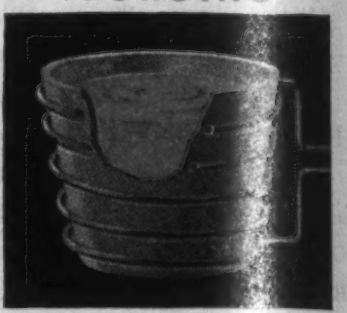
ANNEALING



BRAZING



FORGING



MELTING

***Van Norman High Frequency Induction Heating Provides a most effective and economical method for Hardening, Brazing, Soldering, Annealing, Forging, Melting...ALL WITH ONE UNIT!***

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Add up the savings in time, the economy of operation, the ease and speed of changing from one job to another, and the wide range of work that can be done and you'll find the Van Norman "Power Package" pays for itself out of savings in very short time.

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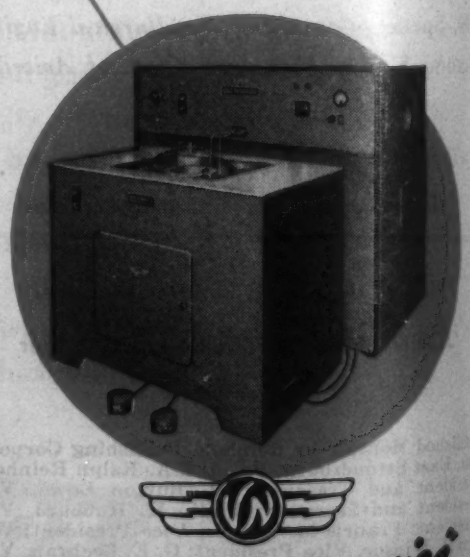


**VAN NORMAN COMPANY**
*ELECTRONICS DIVISION*
**SPRINGFIELD 7, MASSACHUSETTS**

*"It pays to Van Normanize"*

# The Production Front

by Harold A. Knight
*News Editor*

*Aircraft to be 36% 1944 war production; ships, 22%. . . . Landing craft gains 80% in two months. . . . General production peak in mid-October. . . . When Germany is beaten, 35% of war facilities will switch to peace manufacture. . . . We tailor copper consumption closely to supply.*

*Copper in Britain more abundant than here. . . . Use of steel cartridge cases may be revived. . . . Curtailed use of incendiary bombs relieves magnesium. . . . Fractional horsepower motors chief bottleneck. . . . Razor blade manufacture 73% of normal. . . . Machine tool orders pick up sharply.*

*Manpower particularly critical in foundry and forge industries. . . . 12,000,000 trained for war work. . . . Our metal friends parade behind brass band. . . . McQuaid says stainless steel will go to undreamed of heights. . . . Utopia will have arrived when the metallurgist is consulted when the item is designed. . . . Cartoon: the inspector—then and now.*

*Let's apply our war production speed to restoration! . . . Anecdote of some fancy British metal cutting. . . . G. I. Joe pockets the jeep's distributor rotor. . . . Let's not pussyfoot on scrapping war materials. . . . Two products for garbage disposal.*

## Aircraft and Ships Are Chief Focus

Aircraft will account for 36% of all war production in 1944, according to Donald M. Nelson, WPB chairman, who explains that the Army and Navy have let down the bars somewhat on secrecy on the theory that our huge quantity figures will disconcert the enemy.

Shipbuilding will have accounted for 22%; guns and fire control equipment, 5%; ammunition 7; combat vehicles, 8; communications and electronics, 4 and other equipment and supplies, 18.

A total of 8,343 planes was delivered in April, bringing the 4-month total to 30,009. WPB hints of "big things ahead" in shipbuilding. May deliveries of landing craft and warships were scheduled to jump 80% over March.

The year's war production peak will probably be reached in mid-October, after which a slight decline will take place over the rest of 1944.

"Only a very limited civilian production will be possible until the defeat of Germany," stated Charles E. Wilson, executive vice chairman, WPB, recently. "When that happens, 35% of the productive capacity now tied up with war work will be available for peace production.

"We need three plans: One, for carrying out war production successfully by adjusting to changing military requirements and manpower shortages; the second, one for carrying out essential civilian production coincidentally with war work by using manpower and facilities freed after the successful invasion; the third, a long-run post-war plan for full production and full employment —a long way off."

An illustration of current expansion in civilian goods manufacture was the recent issuance of production quotas for 376,768 electric irons to eight additional manufacturers, bringing the total so authorized to 769,338 irons.

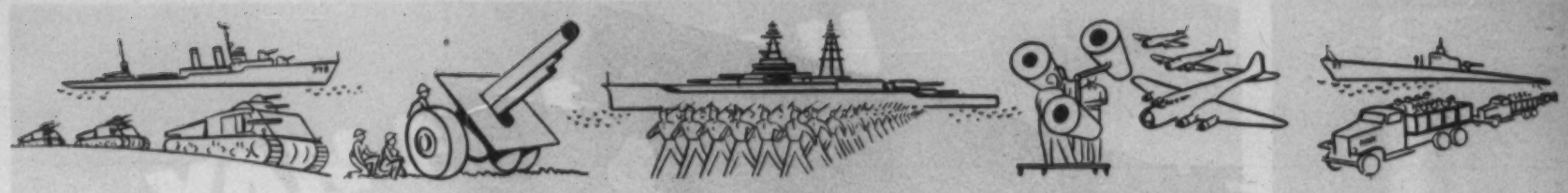
### We Always Talk About Copper

Copper remains ever in the forefront of critical metals. The Army and Navy estimated 1944 needs for 3,637,000 tons, of which 45% could be scrap, which is 307,000 tons more than our probable supplies. However, requests have been pared down in actual allocations so that a surplus of over 50,000 tons should result.

The copper supply situation in Great Britain is so satisfactory that less metal will be purchased from Northern Rhodesia and elsewhere than formerly. Relatively, the United States' supply is not as good as Britain's.

The release of 3,200 soldier-miners for work in the copper mines last August and September, together with cut backs in small arms ammunition, helped relieve the copper situation then.

Operators, however, still need about 2,700 additional men for mines just coming into production and to ex-



pand going operations in others. Copper smelters are demanding about 1500 new workers. Women cannot be used in any of these operations.

**Steel Cartridge Cases Again?**

There are hints that steel cartridge cases will be manufactured again in the fall to relieve copper. Meanwhile the Lowell, Mass. ordnance plant that produced both brass and steel cartridge cases, has been closed down; development contracts of Western Cartridge Co. for steel cases have been terminated; and the Chicago plant of American Can Co., built for case cup production, is being dismantled and the equipment stored by the Army.

Now it can be revealed that development and manufacture of 0.50 calibre steel cases was entrusted to six main companies. Carnegie-Illinois and Jones & Laughlin worked on metal development.

Making of the case cups was delegated to American Can because of previous somewhat similar experience and equipment. Remington Arms, U. S. Rubber and Western Cartridge also contributed.

According to one version, the chief reason for discontinuance of steel cartridge case manufacture was the bringing under control of the Nazi submarine menace.

Idle and excess stocks of steel aggregating more than one quarter million tons are now listed with WPB regional offices. However, there are many steel products still in short supply and on which delivery promises are considerably extended.

In view of the improved situation, all restrictions on the use of corrosion-resisting steels in aircraft, except columbium-bearing type, have been removed.

**Genuine Scarcities Are Few**

Chromium and nickel have not become freely available, states WPB, but their alloys are not as tight as formerly. Shipments of magnesium forgings in February rose 63.6% over January; of extrusions, up 52.7%; of sand castings, up 6%.

Dropping of incendiary bombs has fallen off sharply, which is one reason for sharp cut backs in magnesium production. WPB has become more liberal in allowing the use of tantalum, implying better supply.

## War Speed for Peace

*A few months ago the world was told the story of the carbine—how the Army laid down a deadline for design completion; how a tiny gas escape hole was not the correct diameter and made the gun balk; how the faulty hole was not discovered until just before deadline.*

*Recently we learned of the Bazooka—30 days allotted for design and production of thousands, with accomplishment 89 minutes before deadline, shipments starting overseas before the stains on the gunstocks had dried.*

*American ingenuity and speed, happily married, accomplished these and thousands of other seeming impossibilities.*

*Let's carry it a step farther! When the war ends, let's use the same speed to put our country into healthful and happy condition again and do our share (but no more) in helping restore the world.*

*There is a certain generation of Americans entitled to calm peace and prosperity for its remaining days—the generation that fought in the first World War and gave sons to fight in this.*

*Let's use ingenuity and speed for the restoration!*

Users of cadmium can now keep a 30-day inventory, having previously been forbidden any inventory. The abundance of scrap aluminum is attested by the low price of $4.50 per ton as against $60 several months ago.

One of the worst scarcities continues to be fractional horse power motors. Some bombers use as many as 250 such motors. Unfortunately, many items of civilian goods require these motors, such as refrigerators, washing machines, vacuum cleaners and electric fans.

Inventory stocks of finished antifriction bearings in plants of producers average two weeks' supply, with a goal of a month's supply. Bearings in process of production average two to three months' inventory. Sleeve bearings are reasonably available. Some manufacturers find it difficult to obtain oil seals.

Probably a typical civilian item made of metal is a razor blade. For civilians, exclusive of the Red Cross, in 1944, each razor blade manufacturer is being allocated, under Controlled Materials Plan, enough material to make 73.28% as many blades as he shipped for domestic consumption on an average in 1940 and 1941, which results in 7.5% more than shipped in 1943.

Despite gloomy pictures of the machine tool industry, new orders in April exceeded shipments for the first time since August, 1942. Orders gained 33.9% over March.

**Now as to Manpower**

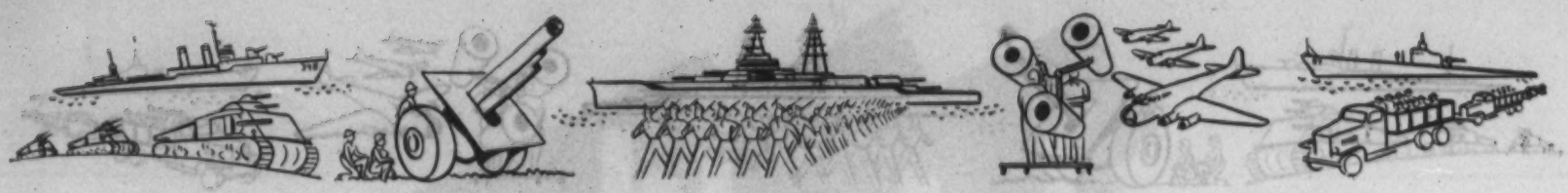
Having brought ourselves up-to-date on metal-power, so to speak, let's consider the manpower situation.

"National statistics alone are no longer significant. Local situations control the pattern of action. Great flexibility in programs and in administration is required. Tight labor areas are loosening up. Loose labor areas are tightening.

"Some critical labor areas are getting more critical. Unemployment is developing in some communities while serious labor shortages are increasing in others."

So spoke Lawrence A. Appley, executive director, War Manpower Commission, before a recent meeting of the Society of Professional Engineers. Continuing, he said:

"By far the largest armed forces in the history of this country have



been mobilized on time, despite conflicting figures to the contrary, and have been fully supplied in record-breaking quantities. If circumstances require increasing strength of the armed forces, they will still be met —and on time. There were many who maintained this could never be done. The stark fact is that it has been done."

One of the most critical labor shortages is in the foundry and forge industries, which are expected to meet 20% higher war equipment schedules by fall. Key plants in these industries number 300, doing at least 75% critical war work.

At least 20,000 more workers, mostly common laborers, must be obtained immediately. Among remedies considered are improving both working conditions and wages.

Those who have enrolled in Federal, State and local training programs in the past four years number 12,000,000.

## Stainless Steel—You'll Be Surprised!

What was to us an all-time high in showmanship—at least since Barnum's hey-dey—was the annual dinner of the Boston chapters of Army Ordnance Assn., American Society for Metals and three other New England organizations at the Hotel Statler, Boston, on May 5.

Seated on the rostrum was the 60-piece Boston Port of Embarkation Band, resplendent in uniforms, with the large gold-plated bell Sousaphones issuing ump-pas in the back row.

The time came for the speakers of the evening to march upon the platform. A nucleus of the band formed in the lobby. Playing "Stars and Stripes Forever" and under massed colors, they one-twoed up the aisle, the speakers in evening dress trailing behind, looking a bit sheepish—such men as Dr. Marcus A. Grossman, William H. Eisenman and A. H. d'Arcambal.

It was a field day for humorous stories, scatterd profusely among the more serious bill of fare. Thus, a columnist for a Republican newspaper became tired of writing against the New Deal and decided to write about Spring, especially welcome in a war-torn world. He showed his copy to his wife. Exasperated, she remarked: "Mark, you're still writing against the New Deal. You say: 'The sap is running again'."

## Halo Over the Inspector

*by V. M. McConnell*

[*News item: "The plant inspector was formerly the most poorly paid employee. Now he is a key man of production," states Harry W. McQuaid metallurgist, Republic Steel Corp.*]

*The plant inspector of* 1902
*Had a useless*
*Ill-paid job to do.*
*In a clanging plant*
*Where men were men,*
*The things he did*
*Seemed useless then.*

*But the plant inspector of* '44
*Gets paid as much*
*As the boss, or more.*
*He checks and figures*
*And foresees jams*
*And warns the boss*
*With diagrams.*

In the afternoon we took the most notes on the talk of Harry W. McQuaid, assistant chief metallurgist, Republic Steel Corp., on the subject of "Trends in Steel." Here are some of those notes:

The last war gave impetus to the control of steel, the key man being the chemist and the inspector. There was no metallurgist then. ("Those were the happy days.")

Mass production caused the need for uniformity, and the chemist gradually became a metallurgist—he usually had whiskers and a foreign accent. Inspection became closer and closer, and by 1930 it was realized that great changes in metal working and treatment were in the offing.

Eventually hardenability and Jominy tests came along. Brand names seemed to be on the way out. There was realized the need for good heat treating and quenching equipment.

As to N.E. steels, the users' attitude is often that they are okay—for the other fellow. But you've all got to knuckle down to three-alloy steel.

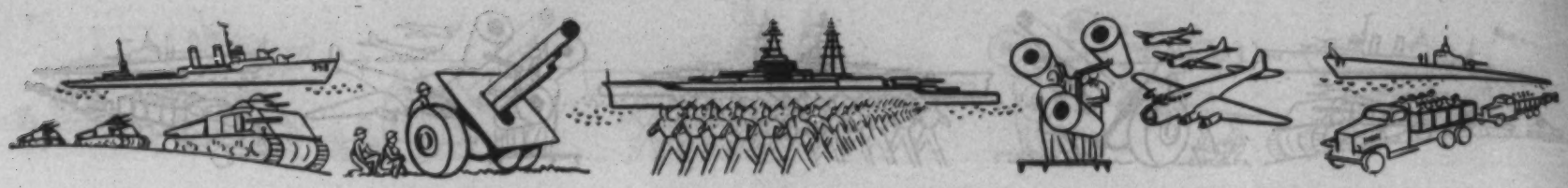
There are now 200,000 tons of alloy scrap to be taken care of monthly—perhaps a drug on the market. Some day scrap will again be scarce and pig iron will be the major raw material.

Perhaps then electric furnaces will have the advantage, particularly if electric power prices drop. It is going to be difficult to make plain carbon steel because of such rich alloy residues in scrap.

There is an excess of blast furnace and bar mill capacity. There has been a big increase in strip capacity, but little excess. Trends in steel will be towards better service and better finish.

Development of stainless and heat-resisting steels will be greater than any of us now believe possible, and faster than any other steel product. Continuous casting of billets may eliminate ingots and improve steel's properties.

Methods of testing become increasingly important. Good quenching is ever more imperative. The homogenity of the quenched structure will be insisted on.



Martempering has more promise than in any other related field. Salt is found to have the same cooling rate as oil. Induction heating and flame hardening have great futures.

Among other trends are those to low alloy steels, high-carbon-low alloy steels; towards Magnafluxing and hardenability studies.

Fundamentally, all steels will have to be made to analysis—whether the steelmakers want it, or not. The inspector has newly won prestige—he used to be the lowest paid man in the plant.

Finally, this war will greatly improve the prestige and position of the technical man in every field. When Utopia is attained, the metallurgist will be called in when the piece is designed—not when the piece has failed through no fault of metallurgy.

## That's Fine Cutting!

A visitor from England gave some figures on carbide milling of steel he had witnessed in that country. Roughing cuts were made at 600 surface ft. per min., while a finish cut was run at 1850 surface ft. per min., with a depth of cut of about 1/32 in.

The cutters had brazed-in carbide bits, and the work was "90-ton steel" —steel with a tensile strength of about 200,000 p.s.i.

The surprising feature of the operation was the finish obtained, the observer reporting a surface of four microinches average roughness following the finish cut.

## Medals, Bah!—A Distributor Rotor!

The present war will be the basis of reams of literature for many years to come — novels, stories, "short short" stories, bibliographical sketches —not to mention the more serious lessons learned in ordnance manufacture and military strategy and tactics. West Point cadets will devote thousands of hours to studies of the text books written.

Some books will be collections of anecdotes about the G.I. soldier, written by some Ernie Pyle. Here is one for the book, told by Brig.-Gen. E. E. MacMorland, chief, maintenance branch, field service div., Office of Chief of Ordnance.

The Ordnance Department for a long time wondered why there was such a demand for distributor rotors for jeeps, trucks and other ground automotive equipment. Investigation revealed that the G.I., upon parking a jeep, took out the easily detachable rotor and pocketed it, thereby assuring that the jeep would be there where he left it for his future use.

The idea quickly spread. The G.I.'s soon learned that the possession of such a rotor gave them the key, so to speak, to any parked jeep. A certain prestige was built up around the G.I.'s who owned such a rotor. Not to possess such a "key" was like living on the wrong side of the railroad tracks.

Moreover, the holder of such a rotor became a handy man with the ladies of Italy and Sicily—the old, old story of a young chap with an automobile in his own home town. Never did an owner of a Phi Beta Kappa key or a medal awarded by a technical society have more Nose-in-Airness.

## Uncle Sam's Surplus "Plant"

Perhaps it is not too early to give a thought to Uncle Sam's excess "plant," as the telephone company calls all their equipment, when the war ends.

It is recalled how after the first war, idle merchant ships rusted away in the upper Hudson River; how millions of tons of Government steel fell into the hands of fly-by-night dealers who had neither knowledge of the steel scrap business nor ethics.

One prominent and supposedly bona fide scrap dealer fled to Italy to escape prosecution for defrauding Uncle Sam on a scrap deal. The whole thing was a mess.

Now there is some talk of stock piling scrap steel in the same manner as critical metals, like tin, antimony, chromium, etc. Our Liberty and Victory ships might well be broken up for scrap immediately after V-Day and not allowed to rust in the upper Hudson.

At any rate, these ships are a makeshift, with not too much confidence in them, the way they have been foundering. Moreover, their junking would afford employment to returned servicemen.

Though we will doubtless keep more armament on hand than after the first war because of lessons we have learned, the great bulk of it will be useless and had better be scrapped in a methodical manner.

There is a question whether Government stockpiling of scrap is feasible—but at any rate it will be best to be prompt with our scrapping, lest too much capital be tied up in an idle and useless "plant." We can sell our scrap through reliable dealer channels. All this ferrous and nonferrous waste will save our depleting ores.

Some marketing finesse will be needed in order not to depress the price unduly and make it prohibitive for scrap dealers to stay in business.

The logical time to lay plans for the enormous scrapping program is when our Second Front invasion promises to be successful. From there on, let's use speed in planning and the final execution of those plans!

## Conversion to a Related Product

Men who formerly designed and produced "Disposalls" (devices that grind up waste food and wash it down the drain) are now turning out Bazookas, or rocket guns, in a plant of General Electric Co.

After all, in view of the low esteem in which we hold members of the Axis, isn't the Bazooka a piece of equipment for disposal of garbage, too?

The Army gave an order to G. E. to design, develop and produce thousands of "Launchers, Rockets, AT, M-1" within 30 days—really a 6-month job. Engineer Jim Powers was given the headache.

The assembly line was one of the oddest in industrial history. The bazookas were produced in two plants a half mile apart. They were shipped overseas before the stain on the gunstocks was dry. The last bazooka came off the line 89 minutes before the deadline!

## You and the Paper Situation

It is 17 months now since your editors have reported to you on "the paper situation," which has a closer connection than you may realize with the type of editorial service you receive from M&A and other magazines. A new progress report is due now, if only because you must have noticed how thin our paper has become, and wondered.

The paper order currently in force restricts all magazine publishers of any size to the use in 1944 of no more than 75% of the paper tonnage consumed in 1942; the restriction must be accomplished notwithstanding considerable pressure from circulation growth and a heavy increase in the demand for advertising space in all strong industrial publications. The necessary reduction in tonnage is achieved generally by sharp reduction in the thickness of paper stock used and in the trim size of each journal. Some publishers have been fortunate enough to be able to discontinue or considerably curtail the distribution of "weak sister" or less popular journals and to transfer the paper thus saved to more favored publications, so that the latter may carry that much more advertising or continue to be printed on de luxe paper.

METALS AND ALLOYS, however, had no alternative but to consider doing one or a combination of the following to reduce our paper consumption: (a) cut down the weight of paper stock used; (b) reduce or limit the magazine's circulation; (c) refuse or limit advertising space; or (d) decrease the quantity of editorial material. Actually we concentrated most of our paper-conservation effort on the reduction of paper-stock weight and reducing the trim size, believing that readers and advertisers would prefer to see the thinner paper used than to suffer a reduction in editorial volume or advertising-space availability. The importance of maintaining high editorial volume is obvious to everyone; not all readers are aware, however, that the advertising pages of technical magazines also carry much informative material that is of direct help in war production and design.

But here is what we really want you to understand: By reducing the paper stock to its present thinness METALS AND ALLOYS has been able to do something unique among the 10 or 12 leading metal-producing, metal-working and design magazines—M&A has actually *increased* its editorial content (the number of editorial pages per issue) in recent months, now carries *more editorial material per issue than any other metal-industries magazine* and has the highest editorial percentage of all but the weekly magazines in the field.

For example, this issue of M&A contains 88 editorial pages, whereas the December 1942 issue (the last one before the paper restriction was applied) contained 74 editorial pages—a gain of 14 pages per issue in the interim. Among the other important magazines in the metals or design field editorial volumes range from 78 down to 52 pages. The extra editorial pages in M&A have gone into feature articles, of which we now publish an average of 7 per issue as compared with 5 in 1942 and into the "Engineering File Facts" department. And next month's feature section will contain a still additional 5 or 6 pages to accommodate a new editorial service that will be presented at periodic intervals.

To you, this report is significant, for it is your assurance that we have kept our promise (made in the February 1943 issue, page 313) not to skimp on editorial quantity or quality and despite the paper shortage that we have actually increased the scope and amount of M&A's editorial content.

—The Publishers

*(More Editorials on page 1387)*

*One of the Inland cold reduction mills, which reduc strip to precise thickness and produces a lustrous finis*

# For Finer Steel Products . . . Tomorrow

Consult Inland when plans are started for parts or products which must have the strength, utility, and beauty that can come only from steel sheets and strip.

Inland was among the first to install modern continuous mills. Its engineers and metallurgists have contributed many notable advancements to sheet and strip production methods and quality control —resulting in unsurpassed uniformity, workability, and finish.

Inland experts are ready to help you select the right steel for finer products and economical fabrication—whether the products are for wartime use, or for the markets that will follow Victory.

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# Centrifugal Casting of Steel

The war has been an impetus to the further development and progress of a number of processes in the metal and other fields. Otherwise they might have been some years in reaching more advanced maturity. This is true of powder metallurgy, precision casting, die casting, plastics, induction heating and particularly the centrifugal casting of metals. The strides that have been made in the production of steel castings by the centrifugal process are noteworthy.

Previous to the war there were only a few companies which were using this process for making steel castings, though the production of cast iron pipe in revolving molds, both metal and sand lined, had reached large proportions. The Ford Motor Co. had for some time been using it for certain special steel parts, particularly gear blanks. Minor products were being made by a few other companies.

The demand for certain war products which it was found could be made by centrifugal casting gave a distinct impetus to this process and the development is expanding to large proportions. Some companies have adopted the process on a large scale, particularly the American Cast Iron Pipe Co., Birmingham, Ala., which is now producing large quantities and varieties of centrifugally cast war materials from electric furnace steel in over 100 casting machines. Ford has decidedly expanded its steel production by this process.

A survey made some months ago by the Steel Founders' Society of America revealed that there were then about 16 companies actually producing centrifugally cast steel products with at least four others which had installed such equipment. It is reasonable to calculate that today this total of 20 has at least been increased, some say to certainly 30 companies. But the process is not confined to ferrous castings—its use in the non-ferrous field has reached large proportions.

One of the interesting features in steel is the fact that the art has been so improved that many products, not previously considered producible by centrifugal casting, are now being successfully made. The advantages of the process are manifest—so pronounced in fact that it is safely predicted that it will continue to hold and probably increase its prominent position in the post-war era.

—E. F. C.

# The Machine Tool Industry's Future

One of industrial America's popular indoor sports for the past several years has been that of predicting dark days for the machine tool industry. The situation in the industry is well known, and is typical of that in several others—the war program demanded a tremendous production over a few years, with costs and prices a secondary consideration, but with the customer, Uncle Sam, recapturing so much of any profits that the companies have been unable to build up reserves during these good years against the lean years to come. Now these pieces of equipment hang like a sword over the industry's future, able to destroy their markets for many years.

How the machine tool builders propose to meet this situation was outlined at the Machine Tool Electrification Forum at Pittsburgh, May 1 and 2, sponsored by Westinghouse Electric & Mfg. Co. After J. Y. Scott, president of the National Machine Tool Builders Assn., had said "The machine tool industry is facing the greatest crisis in its whole history," Frederick S. Blackall, Jr., president of the Taft-Pierce Mfg. Co., called upon the designers and engineers "to render obsolete, if you can, every machine tool in existence, through the development of new and improved mechanisms. If existing machine tools represent the ultimate product of American ingenuity, then indeed we are in dire straits, for there are probably enough of them in existence now to last for twenty years," he said. "But if . . . you can announce a milling machine which will outmill any yet conceived, a drill which will outdrill, a lathe which will outturn, have no fear—you will find a ready market for your product. As engineers, you are the creators. Many other things can be done, and must be, to lend our industry a greater measure of stability, but none is more important than your job, which is to be fertile with new ideas that will outmode the old.

"America's capacity to produce would be increased enormously," he said, if depreciation reserves were used by industry "year in and year out," to replace old or obsolescent machine tools. Industry must be educated "to the profit-making potentialities which are afforded by the possession of equipment of the latest types."

President Scott, speaking of the post-war production battle, said that designers must design better tools, must design whole processes, to help American industry convert to high production techniques.

This is a truly American solution of the problem. The call is, not for stagnation, not for destruction of what exists, but for progress—for the production of tools so much better than those now in use that the new tools will pay for themselves, and all will gain—the user by the higher production of the new equipment, the maker by the sale of this better product, and the public through the lower prices possible thereby.

—K.R.

# Small Die Castings Rapidly Made

by HERBERT CHASE

*Of unusual interest to engineers and designers appraising materials and methods to be used for future products is the development discussed in this article—a method for making zinc alloy die castings as small as 1/8 in. x 1/8 in. at speeds of several hundred per minute. Parts already in production include slide fastener components and other tiny articles.*

*—The Editors*

THANKS TO THE INITIATIVE of engineers and to some truly remarkable development work by the Crown Fastener Corp. in association with the Gries Reproducer Corp., certain rather extraordinary new possibilities for designers have recently been opened. This work has made possible the manufacture of small die castings at a remarkably high rate and at a cost so moderate that, in some cases, the products compete with substantially duplicate items heretofore made by cold headers, wire-forming machines, screw machines and stamping presses.

The die casting machines in question not only operate automatically but are equipped with supplementary attachments that remove the casting from the die, cut it from the gate, trim off flash and, in many instances, deliver the casting ready for use, except for chemical treatment or the application of plated or synthetic finishes. Despite the small size of the castings, many of them are precisely cored.

Development of the casting machine and its accessories, as well as its production (and, in part, its operation) has been done largely by the Gries Corp. under the direction of L. H. Morin, chief engineer of the Crown Fastener organization. It came about initially through the production of die cast slide fasteners. A great many of the machines are now employed for this purpose. Redesign of the elements of the fasteners has not only improved their operation but has led to their use with marked success in sizes much larger and stronger than any produced by other means, such as cold forging and plastic molding.

In these machines, the elements of the fasteners are die cast directly onto the tape. The new design, details of which are shown in Fig. 1, operates with equal smoothness in both directions. As a result of recent developments the Crown die cast slide fastener is now applied in many ways (chiefly military, because of war restrictions and demands) where it could not be employed before. In addition to the fastening elements cast directly on the tape, there are also die cast separately the slides and certain other elements, such as the stops and locking parts.

More recently, the machine has been used, also with marked success, for making other small die castings, many of which are here illustrated. A majority of these were formerly produced on other kinds of machines but, in most instances, the die cast parts cost less and are equally satisfactory or better than the competing product. Some of those shown have not yet been made on a commercial basis, partly because of war-time restrictions, but, in each instance these parts illustrate the possibilities of die casting which had not been thought feasible previously.

Detailed examination of some of the items should make any engineer aware of possibilities he may never have considered before. In fact, certain individuals with a very large corporation, when shown the castings, requested that sample boards containing them be made up to be passed about for study by their engineers in the belief that they should be made aware of such possibilities.

One type of slide is shown in Fig. 2, assembled with a spring-operated locking element. Also shown are stops cast separately and later applied to the tape by clinching. The slide body is a one-piece casting. Space between its upper and lower portions including the tracks or recesses through which the tape elements pass, is formed by a pair of forked cores in the parting plane. Upper and lower portions are joined by a divider that is cast between the core forks. The divider passes between the interlocking elements along the edges of the tape when the slide is moved.

Two other small cores are fixed to the die. One forms a recess for the torsion spring and a slot through which an ear of the hinged locking device passes. The other is a pin that forms a hole into which one end of the spring extends. Both ears forming the hinge pin support are cast integrally but the holes for the pin are drilled. In die casting the locking element, that serves also as a thumb grip for moving the slide, the hole at its outer end is formed by fixed core pins and the raised lettering on each face is formed by the die. At the hinged end, a recess is formed for the helical spring coil and a narrow recess for the other end of the spring wire. After the wire is inserted later, a staking tool is used to close the edges of the narrow recess over the wire. One of the ears of the part is extended through the slide to act as the locking projection. Although the equivalent of the locking element could be stamped, it would lack some of the desirable features of the die cast part.

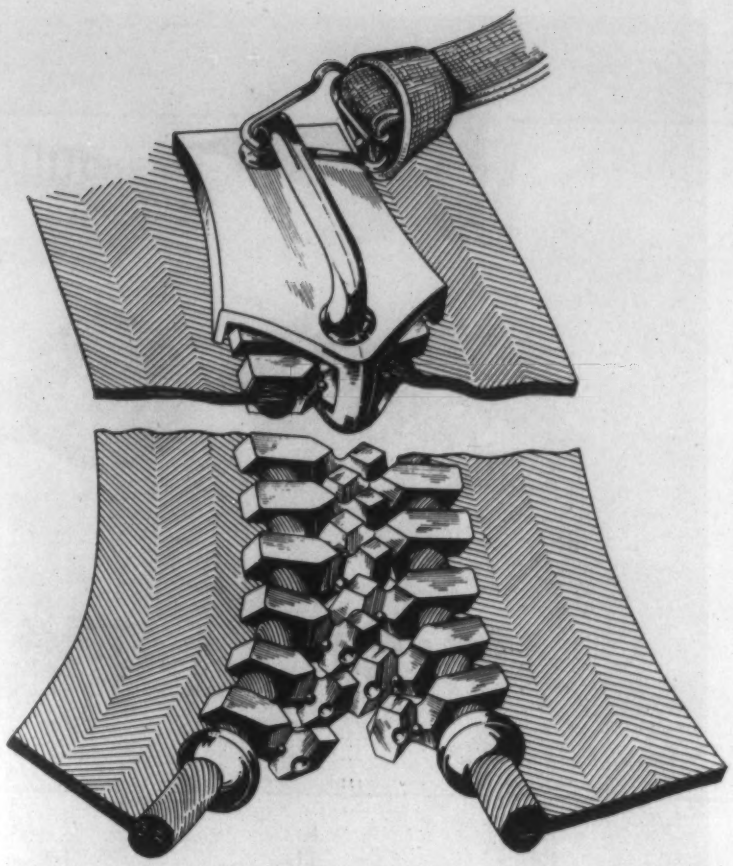


*Fig. 1.—Detail of the new type of Crown fastener that operates with equal smoothness in both directions. The elements are die cast on the tape. Each one has a cored hole through the head, parallel to the edge of the tape. This hole takes the place of a scoop and receives the hemisphere on the neck of the element at each side.*

## Die Cast Parts for Umbrellas

In Fig. 3 are illustrated tips for the rod and bows of umbrellas. The large tip is a simple die casting and, in common with all the other castings shown, is in Zamak 5 (zinc) alloy. The equivalent part can be stamped (drawn), but if made from steel is subject to red rust, and if made of brass, probably would cost more than the die casting and presents no advantage. Rib tips are cast with the axial as well as the cross hole cored. A duplicate part can be produced in a screw machine but requires that one or both holes be drilled either in attachments or in supplementary machines. Both types of tip involve considerable scrap if not made by die casting but practically none when die cast, since flash trimmed off is remelted and reused.

All the parts in Fig. 4 could be produced on the screw machine but several of them would require supplementary operations, either in transfer attachments or in supplementary machines or both and all would involve scrap avoided in die casting. In some, the scrap loss would equal the weight of the finished part. In making the threaded nipples on a screw machine, the small projecting tip could not have the slender longitudinal and circumferential ribs, unless a special knurling tool were applied and the flats on the threaded end would have to be milled.

In the part having a flange and two stepped diameters, production by screw machine would be wasteful in scrap and the transverse grooves on the inside of the flange would require a supplementary machine. To make the part having circumferential grooves and an eye at one end would require milling

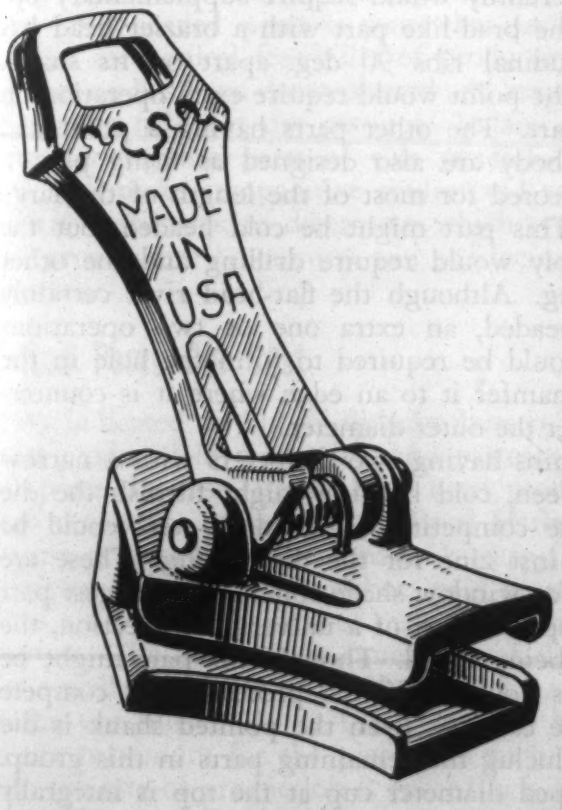
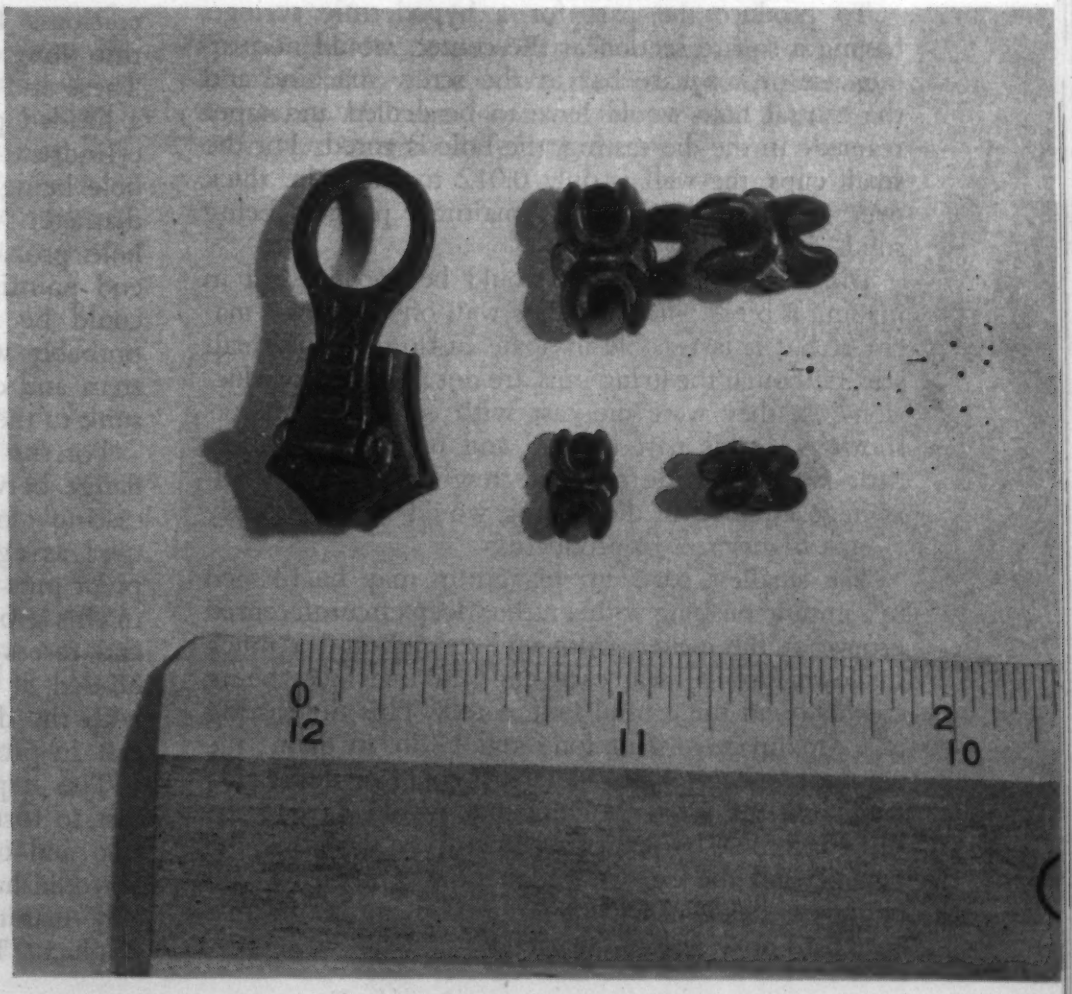



*Fig. 2a and 2b.—These components, including two locking type slides and some stops, are zinc alloy die castings some of which have several cored openings.*



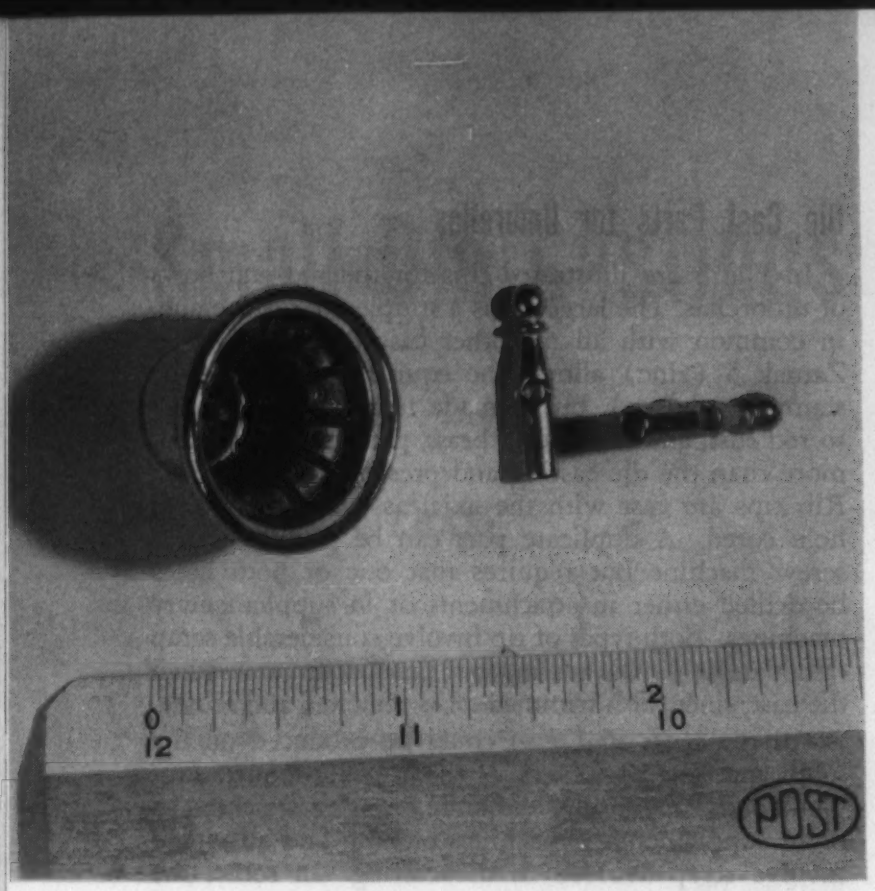



*Fig. 3.—Die cast tips for the rod and bows of umbrellas. Heretofore, the corresponding parts have been stamped, made on the screw machine or molded from plastic.*

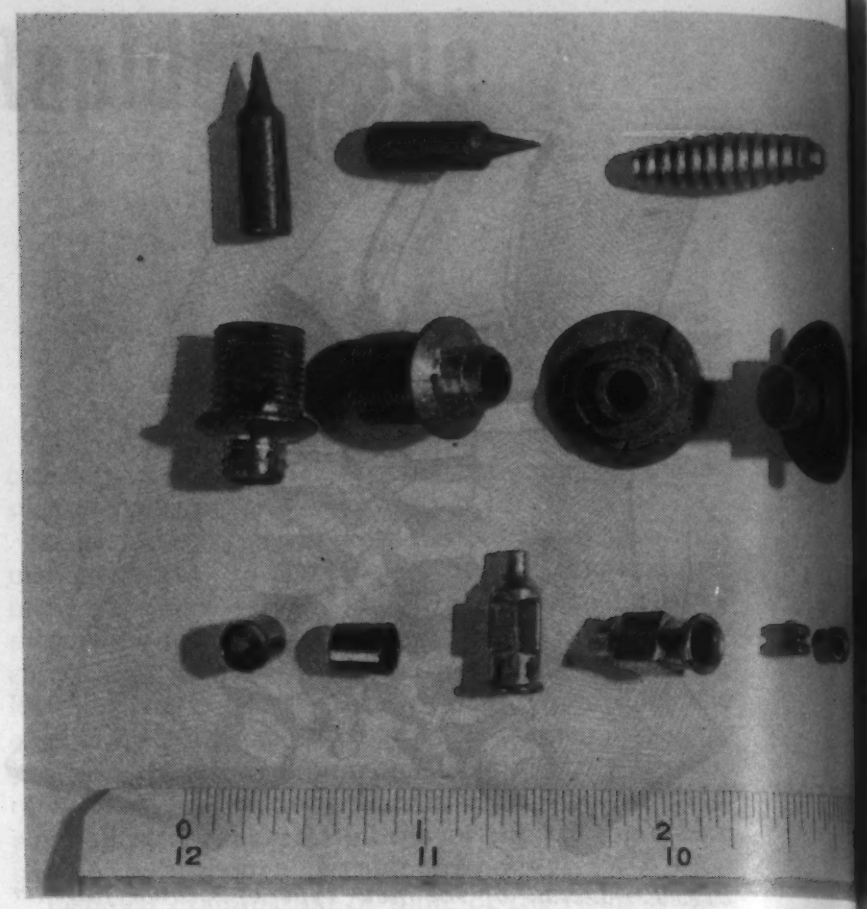



*Fig. 4—All of these parts, although they could be made on the screw machine, are die cast, presumably at lower cost.*

of flats and cross drilling on the screw machine but no extra operations except flash removal are needed on the die casting. This part is a weight for cuckoo clocks and many hundred thousand have been die cast at very low cost.

To produce the part for a hypodermic syringe, having a square section at the center, would necessitate use of a square bar in the screw machine and the central hole would have to be drilled and taper reamed. In the die casting, the hole is cored. For the small cups, the wall is only 0.012 to 0.015 in. thick over half the depth, the remaining portion being solid.

Difficulties undoubtedly would be encountered in making a piece with so thin a wall on the screw machine, but it is feasible in a die casting of this small size. Although the firing pins are not an actual production job, they were die cast with conical points, as shown. As this part is solid and involves relatively little waste if made on the screw machine, any advantage attained in die casting would result possibly from a higher rate of production.

The smallest parts in this group may be likened to a minute bushing with a rather deep circumferential groove at the center, from end to end, and a much shallower groove near each end, the end faces being crowned and the central hole cored. This die casting is approximately ⅛ in. long and ⅛ in. in diam., the casting rate being high. The part could be duplicated readily in the screw machine but would have to be shifted into a burring attachment, as with the die casting, and the rate of production probably would be lower. Beads of this or larger size can be die cast on a cord or wire.

## Die Cast instead of Cold Headed

Parts of the shapes shown in Fig. 5, though die cast, could be cold headed, perhaps with one exception, but some certainly would require supplementary operations. The brad-like part with a brazier head has thin longitudinal ribs 90 deg. apart on its shank. These and the point would require extra operation on a headed part. The other parts having a point and cylindrical body are also designed as firing pins, a hole being cored for most of the length of the large diameter. This part might be cold headed, but the hole probably would require drilling and the other end pointing. Although the flat-head rivet certainly could be headed, an extra one or two operations probably would be required to form the hole in the stem and chamfer it to an edge where it is countersunk to meet the outer diameter.

For the pins having two diameters with a narrow flange between, cold heading might furnish the die casting close competition, providing steel could be used as against zinc for the die casting. These are pivot pins for window shade rollers. The largest part in this group is a part of a universal connection, the end recess being cored. Though this part might be headed, it is doubtful if that process could compete with the die casting. Even the pointed shank is die cast in producing the remaining parts in this group.

The stepped diameter cup at the top is integrally cast to form the head. This cup has a very thin section and could be drawn from sheet stock but then it would have to be soldered to a pointed insert, probably making a more expensive and less satisfactory product. The head is believed to be too thin for

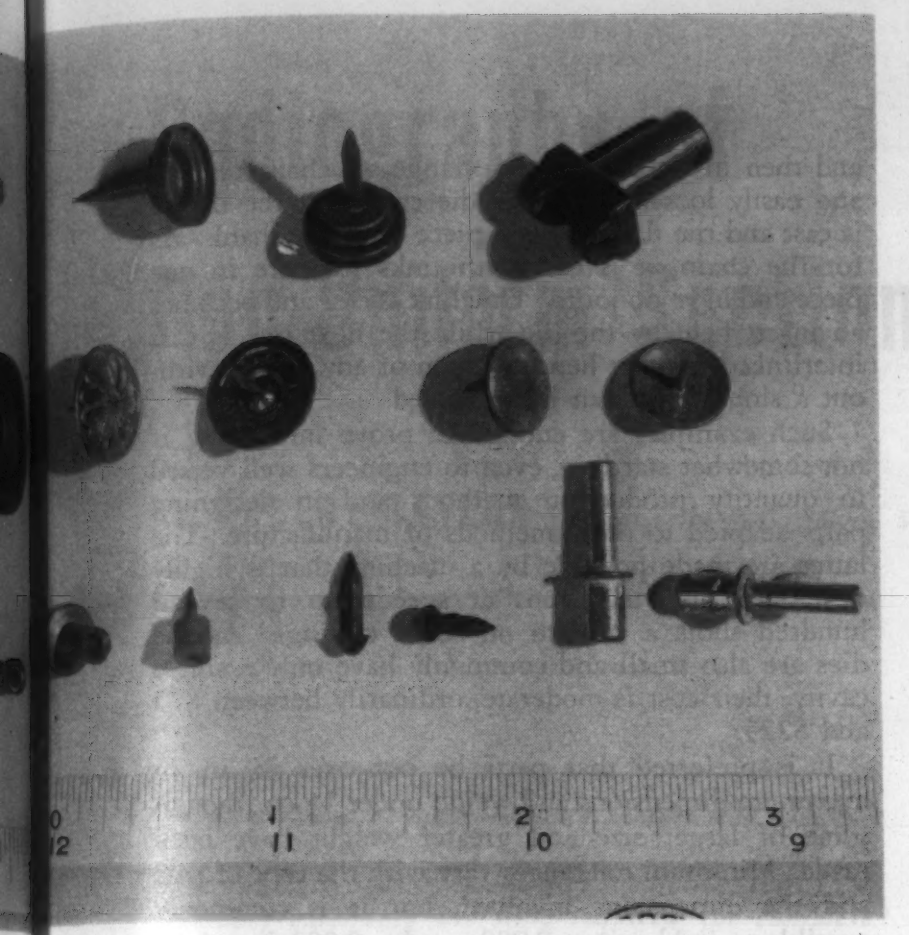


*Fig. 5.—Parts such as these could be cold headed, but those shown are zinc alloy die castings produced with great rapidity in fast, automatic machines.*

production by heading, especially from a shank of so small a diameter. Die cast thumb tacks can have plain or decorated heads as thin as sheet metal types and may prove lower in cost.

To what extent the die castings in Fig. 5 can compete with headed parts is somewhat problematical, but the mechanical feasibility of producing them by die casting has been demonstrated and may well open up a new field for die castings. In any event, engineers designing parts of this general description may well make comparative studies and secure comparative estimates to determine which type of part will prove more economical and satisfactory in other respects.

## Button Parts Die Cast

As indicated in Fig. 6, die cast button parts have been produced in many sizes and patterns and some one-piece die cast buttons have been produced with high economy. In fact, before Pearl Harbor, the die casting process here described took away from Japan (despite its virtual slave labor, paid at most a few cents a day) the business of making shanks for pearl buttons. The cone at the inner end of these shanks has a wall only 0.015 to 0.020 in. thick and the loop at the eye runs 0.030 to 0.040 in., this being close to the maximum for the piece. On such small castings the rate of production is exceedingly high, finish is excellent and the castings are readily plated.

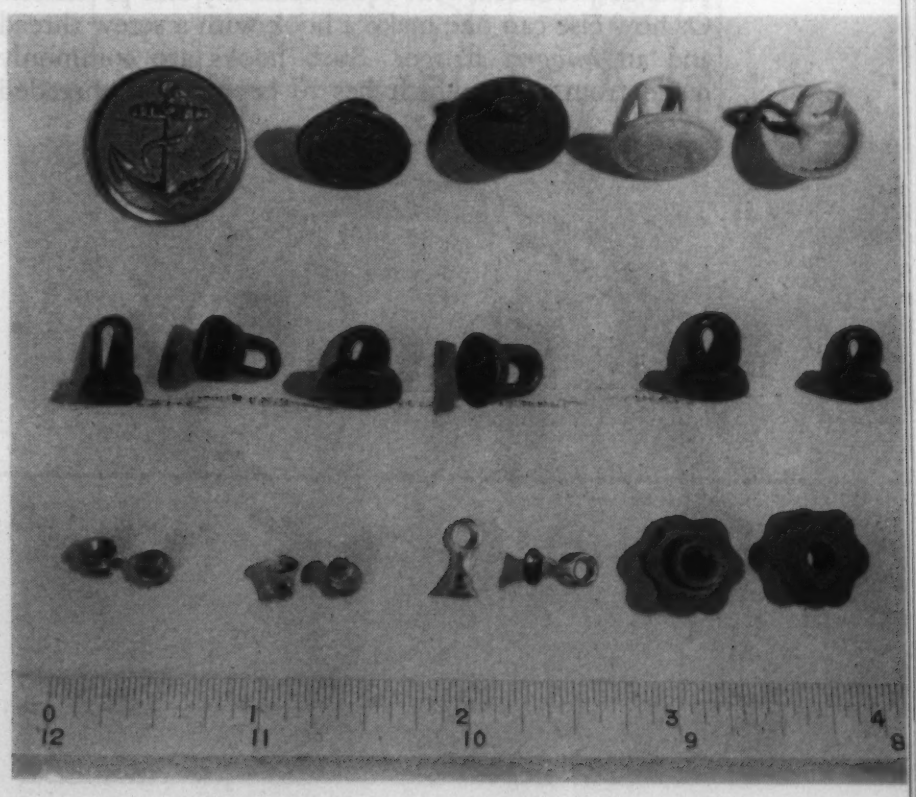
Most of the larger button shanks illustrated are for use as inserts in molded plastic buttons. In these and other cases, the shanks are strong and are a great improvement over shanks made from wire inserted through a hole in a washer and then spread. As will be seen, it is also possible to cast buttons with integral shanks, with and without a decorated top face. If the face requires decoration, all the finely engraved details in the die are faithfully reproduced, as shown in the anchor-and-rope design in which even the rope strands show clearly.

Millions of nuts for service emblems are now being die cast, the outer diameter usually being fluted and a hub formed around the hole, which is tapped after casting. Such nuts cost less than the equivalent cut from fluted bar stock on a screw machine and are better in appearance than a stamped nut having no hub. Almost any kind of plated or enameled finish is easily applied to buttons or, if the part be a hidden one, as in the case of the nuts mentioned, a simple Cronak treatment, applied by dipping or tumbling in less than a minute on parts handled in bulk, meets Army and many other requirements.

## Die Cast Rings and Buckles

Buckles, tangs, rings and slides constitute another type of product die cast with high economy. A die cast ring has no joint to be soldered and its section can be circular, square, oblong or some other shape. Such rings and buckles have been made by the million for Army and similar use. Some such rings are 1 in. in diam. and correspond in section to a wire of only 0.050 in. diam. Tangs with one or more points are

*Fig. 6.—Buttons, button shanks and similar components here shown are being die cast with high economy, many of them for attaching to pearl fronts or molding as inserts into plastic buttons.*



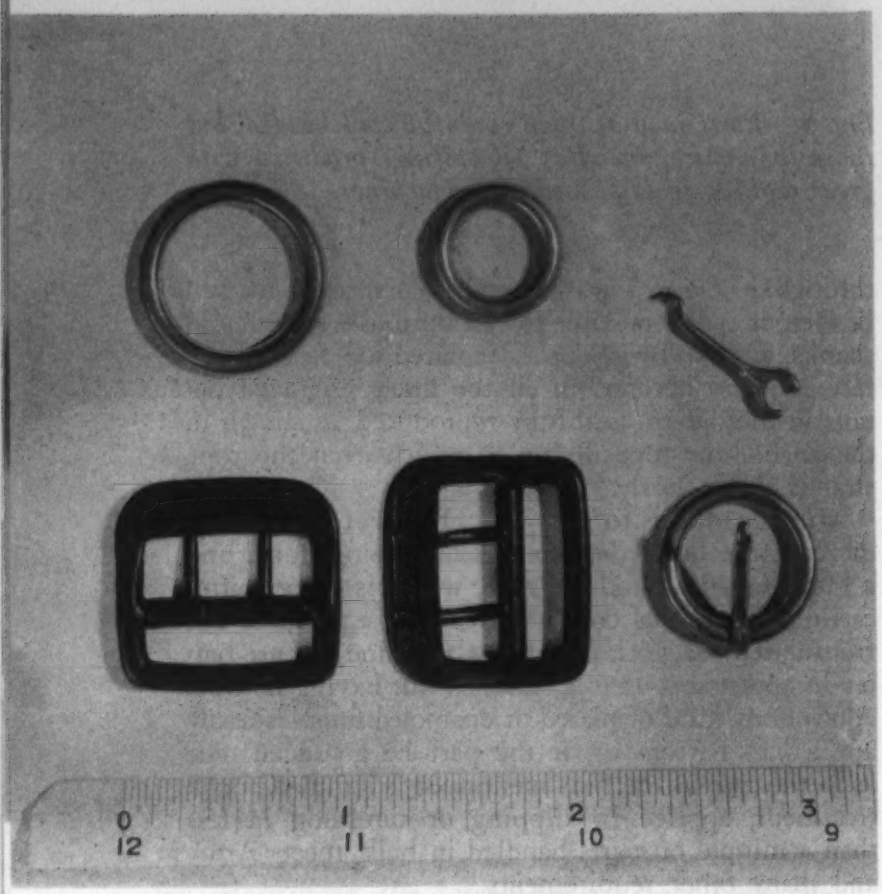


*Fig. 7.—Rings, slides, buckles and parts for buckles are among those die cast to great advantage and at remarkably low cost. The zinc alloy used readily takes plating, enamel and other highly enduring finishes.*

easily die cast and inserted over integrally cast nibs or a split and can be closed around a circular section. Few of these features are feasible in parts produced by other means and die cast elements for such uses give promise of displacing other types because of their advantages and low cost. Fig. 7 illustrates a few of the accomplishments with such parts.

The miscellaneous die castings, Fig. 8, give an indication of certain other possibilities both in respect to size and structure. How else could the very small parts be produced with equal economy and precision? Or how else can one make a hook with a screw thread and an *integral* flange? Such hooks are commonly made from wire, which has to be machine-threaded and then inserted through a flange which is stamped and easily loosened. In the die cast part, the thread is cast and the flange is one piece with the shank. As for the chain, it is cast with links that are in one piece and have no joints. One link is cast and becomes an insert held by the die while the next one is cast interlinked with it; hence a chain of any length without a single joint can be produced.

Such examples are enough to prove interesting if not somewhat startling, even to engineers well versed in quantity production methods and in designing parts adapted to these methods of manufacture. The latter are made possible by a machine that is highly developed and that runs at speeds up to several hundred shots a minute on small castings. As the dies are also small and commonly have only a single cavity, their cost is moderate, ordinarily between $75 and $225.

It is preferred that parts be not over ¾ in. in maximum dimensions and weigh under ½ oz., though some of larger size and greater weight have been made. Minimum tolerances vary with the type of part and the dimensions involved, but it is commonly possible to hold minus 0.000 to plus 0.003 in. where the measurement is across a parting and plus or minus 0.001 in. where the measurement is within integral portions of the die, though somewhat wider limits are preferred.

To date, zinc alloys, which are easy to cast, lend themselves to use in a plunger type of machine, permit of high speed casting and have excellent properties, have been used exclusively. Alloys of higher melting point are not well adapted for use in a fast machine of this type and, except for lighter weight (which is commonly of little significance in parts so small) have few advantages over the zinc alloys. As these alloys are also moderate in cost and lend themselves to almost any type of applied finish, they appear to be ideal for this type of application.

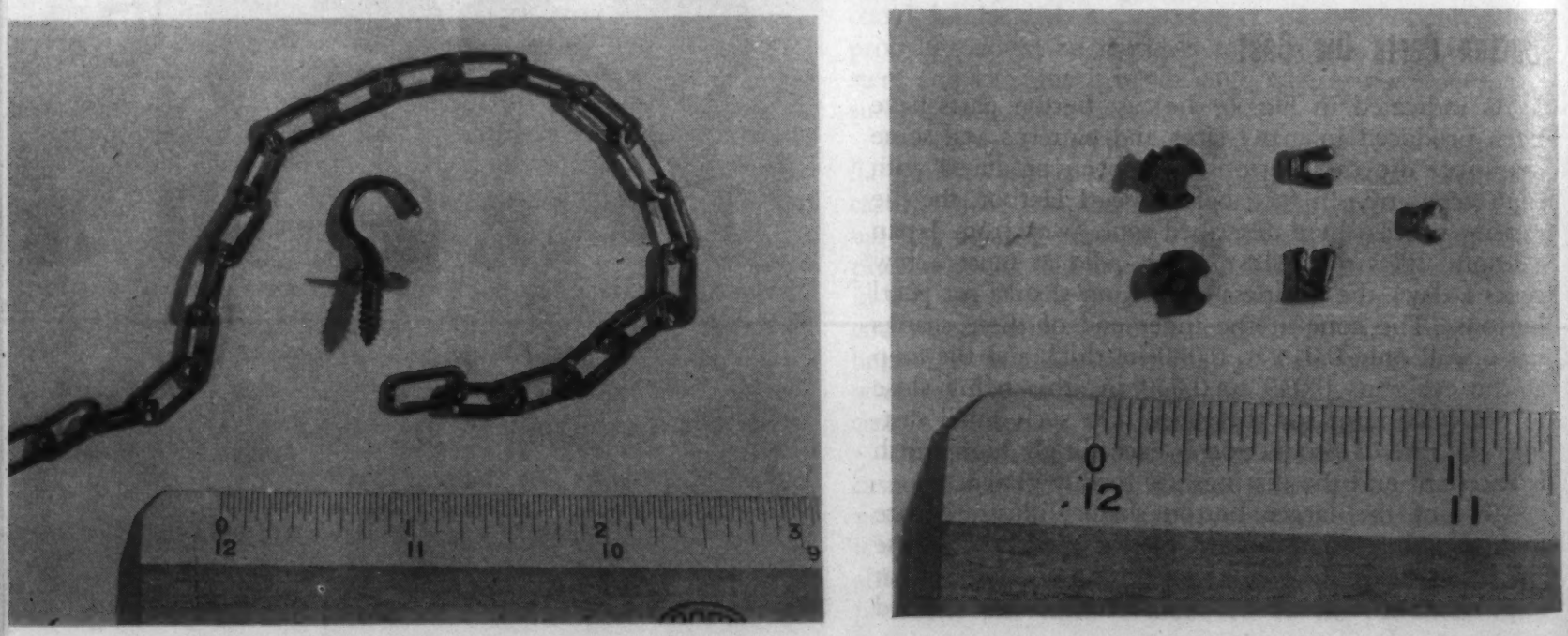


*Fig. 8a and 8b—These die castings illustrate differences in range of size and complexity of die castings produced on the new form of high speed machine. The chain links have no joints and are cast interlocked as shown, any over-all length of chain being producible.*

# Radiography of Non-Uniform Sections

by **ROBERT TAYLOR** *Consultant in Radiography, Spokane, Wash.*

*The problem of radiographing complicated castings of non-uniform sections is conventionally solved by exposing each individual section separately, thus considerably extending the time required for complete inspection of a part. In this article the author gives the details of a recently developed single-exposure technique using two suitably chosen films in one holder that is expected to save much operating time if generally applied.* —*The Editors*

ANY METHOD CAPABLE of reducing exposure time in radiography is worthy of discussion. This has special significance when gamma-rays are used as the source of radiation. The one disadvantage in the use of gamma-rays for radiography has been the necessarily excessive length of exposures. Otherwise radium may be considered an ideal "power plant" and in many instances its use is essential when space limitations make installation of elaborate X-ray equipment difficult, if not impossible.

With the realization that any method which would serve to reduce time of exposure with radium or X-rays is of great importance, Woods[1,2] recently presented methods of utilizing calcium tungstate intensification to speed up exposures. No mention was made in this work of non-uniform sections and the studies were therefore apparently carried out on sections of material over which the range of thickness did not vary, otherwise, even with the intensification offered with calcium tungstate screens, more than one exposure would be required on complicated sections.

A method, applicable to castings of complicated shape wherein the range of thickness over which inspection must be effective might vary to a considerable extent, is discussed in this article.

With reference to calcium tungstate intensifying screens it has been determined that, when utilizing gamma-rays or high potential X-rays, these screens tend to give excessive graininess to the image and are therefore rarely used. Furthermore, they are not suitable for use with certain types of X-ray film. This applies to the two types of X-ray film used in the double film method, namely, Eastman Kodak Type K and Type A.

It is not unreasonable to assume that two films of varying speeds could be loaded in one exposure holder and adapted to a single exposure technique when a casting is encountered whose range of thickness may vary as much as 100 per cent, or more. As a matter of fact the double-film exposure technique has been known for some time but has received little publicity. Seemann and Corney,[3] for example, mention it in a recent paper on the use of radiographic exposure charts and the characteristic curves of X-ray film for determining exposure technique.

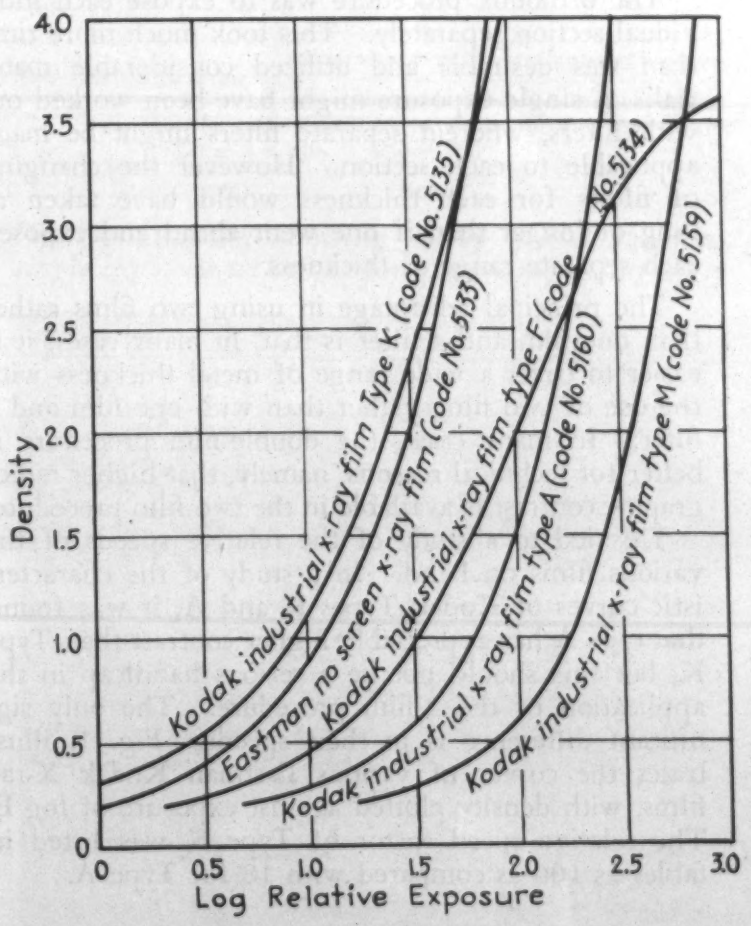



*Fig. 1. Characteristic curves of various Kodak Industrial films.*

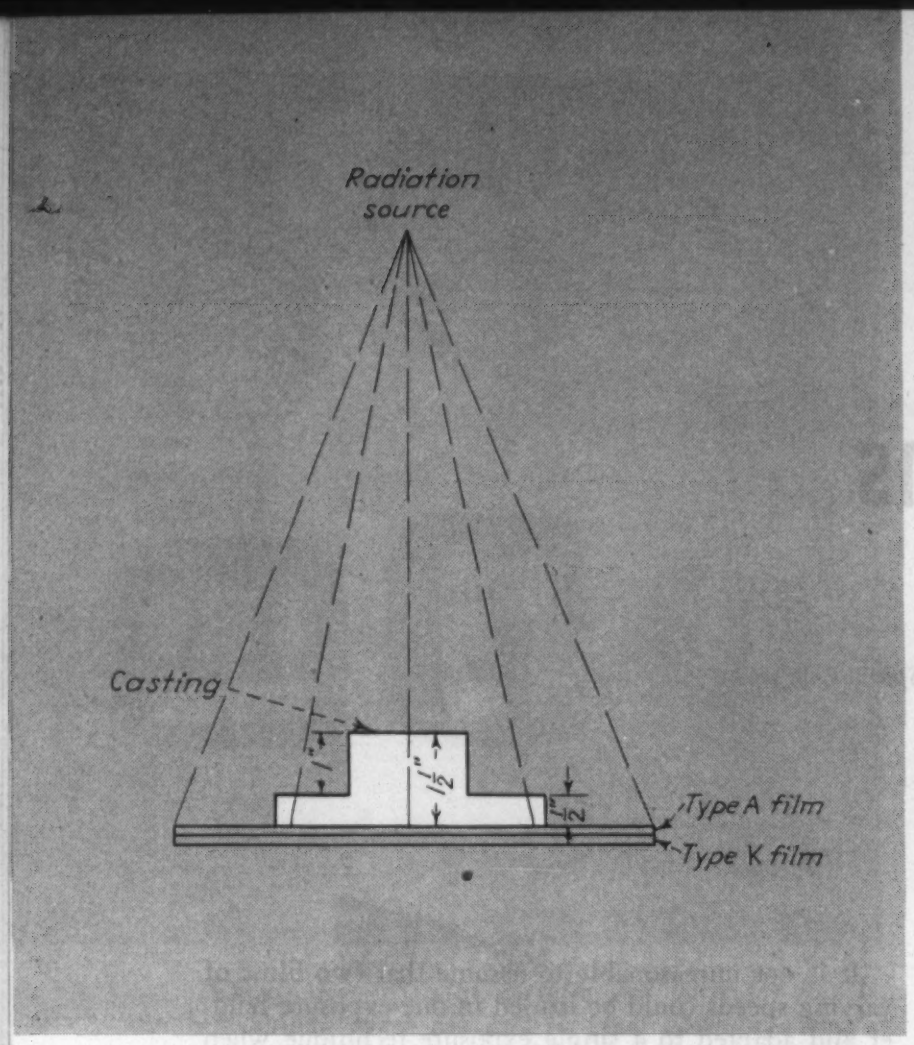



*Fig. 2. Diagram showing manner of set-up for double-film single exposure technique for X-ray radiography of light alloys*

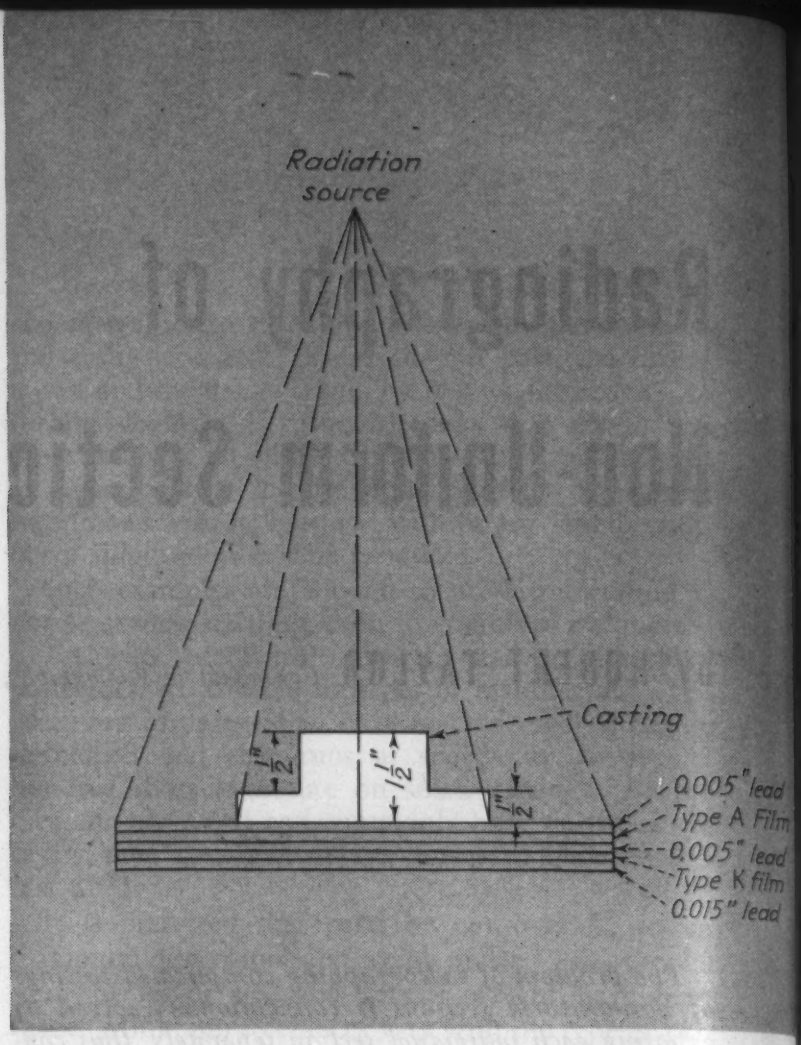



*Fig. 3. Diagram showing manner of set-up for double-film single exposure technique for brass and steel with X-rays*

My initial experience in exposing two films in one exposure holder took place in an X-ray inspection laboratory where frequent requests were made by the production department for quick checking of castings, all of complicated shape and incidentally, with the range of thickness varying considerably.

The orthodox procedure was to expose each individual section separately. This took much more time than was desirable and utilized considerable material. A single exposure might have been worked out with filters, wherein separate filters might be made applicable to each section. However the changing of filters for each thickness would have taken as long or longer than if one went ahead and exposed each separate range of thickness.

The principal advantage in using two films rather than one film and a filter is that, in many cases, it is easier to cover a wide range of metal thickness with the use of two films rather than with one film and a filter. In many cases, the double-film procedure is better for technical reasons, namely, that higher radiographic contrast is available in the two-film procedure.

This led to a study of the relative speeds of the various films on hand. In a study of the characteristic curves of Kodak Types K and A, it was found that type A has appreciably higher contrast than Type K, but this should not be a serious handicap in the application of the 2-film procedure. The only significant difference is in their speeds. Fig. 1, illustrates the curves of various Eastman Kodak X-ray films, with density plotted against exposure of log E. The relative speed factor of Type K was listed in tables as 100 as compared with 18 for Type A.

## The New Method

A double film method for radiography of castings of complicated shape was carried out as follows: If a casting was an aluminum or magnesium base alloy, Type A film was placed nearest the tube and Type K farthest from the tube and one exposure made to cover the varying ranges of thickness of the casting. This is presented schematically in Fig. 2. Lead screens are eliminated in the radiography of light alloys.

If the casting approached was steel or brass and non-uniform in range of thickness a front lead foil screen of 0.005 in. was placed in an exposure holder after which a Type A film was placed followed by another 0.005 in. of lead foil and a Type K film which was backed up with lead foil 0.015 in. thick. A single exposure would reveal two films, one for each range of thickness, with sensitivity satisfactory to detect a void within 2 per cent of the thickness of any section. The set-up is illustrated in Fig. 3.

In approaching gamma-ray problems the same method holds true. Some additional data relating to speed of the two films mentioned have recently been worked out by Nodwell and Morrison[4] with special reference to work done with gamma-rays.

In examining a steel casting whose range of thickness might vary from 1 to 6 in. one would once again be compelled to make two exposures, which would take considerable time. Considering the time consumed in exposing film to gamma-rays the single exposure method would be of inestimable value. As with X-rays the faster film will record the thicker section and the slower film the thinner section.

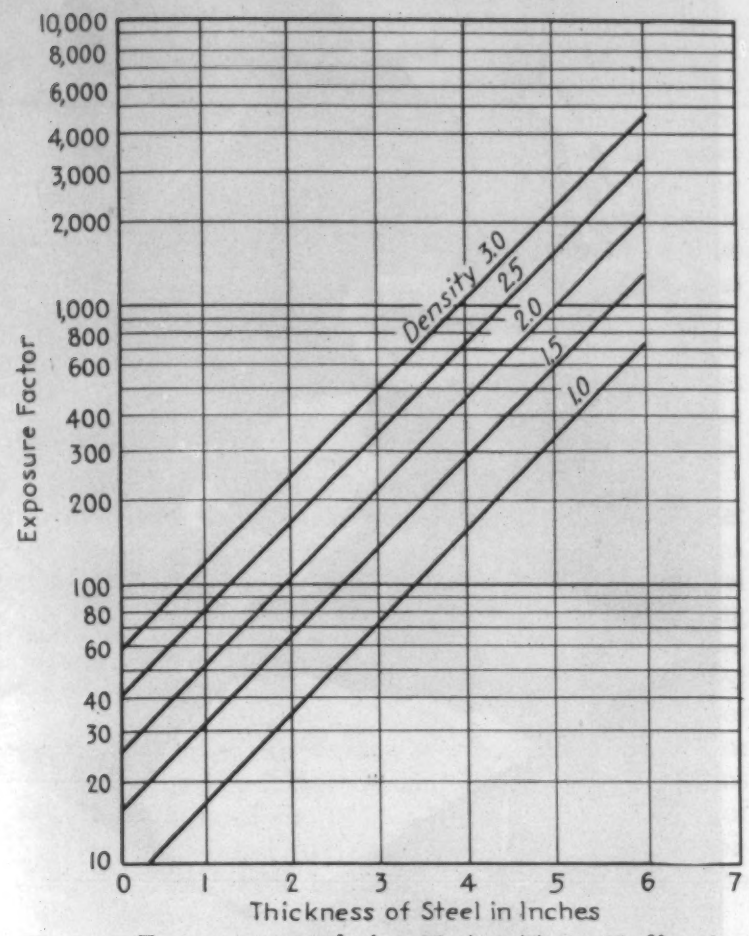



*Fig. 4a. Exposure graph for Kodak Type K film for gamma-ray radiography*

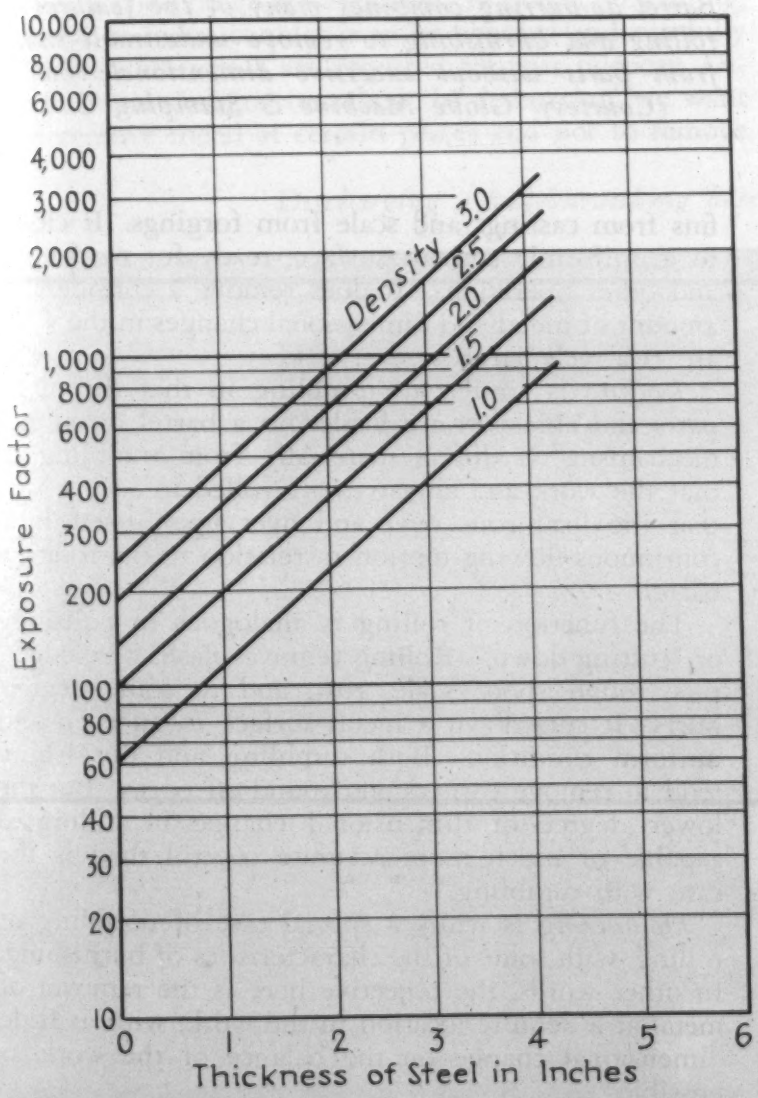



*Fig. 4b. Exposure graph for Kodak Type A film for gamma-ray radiography*

From the graph Fig. 4, it is evident that at exposure factor 500, Eastman Kodak Type K film will record a thickness range of steel of from 3.0 to 5.5 in., whereas Kodak Type A film will record, at the same exposure factor, a thickness range of from 1.2 to 3.4 in. Therefore combining both films for a casting whose range of thicknesses varies from 1.5 to 5.5 in. over its entire range, we may maintain a satisfactory sensitivity in executing a single exposure of the entire casting, in lieu of making two exposures by methods now employed.

In preparing the exposure holders for gamma-ray radiography by the single exposure method, three lead-foil screens are placed in a single exposure holder, the films A in front and K in back being inserted between the lead sheets. This is presented schematically in Fig. 5. All films should be processed by time temperature method.

The slope of the density-exposure factor curve at any density is a measure of the contrast of the films at that density. In selecting films for the double film, single-exposure method this should act as a guide in determining what combination of films will best meet individual conditions.

The two items for consideration are primarily the rendering of radiographic inspection with all possible speed and the conservation of all material possible. Accuracy of inspection must, of course, be maintained at any cost.

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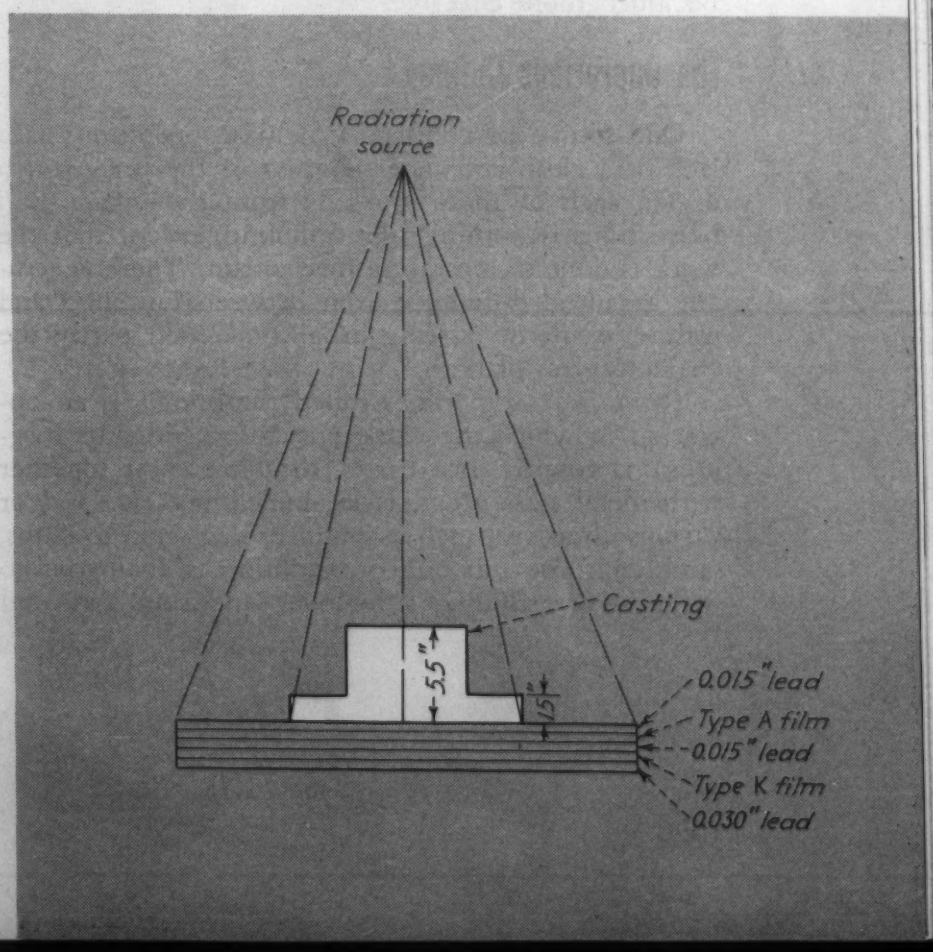
*Note*—Exposure factor $= \dfrac{\text{milligrams of radium x minutes of exposure}}{(\text{source-film distance in inches})^2}$

e.g., for 250 mg. placed 20 in. from the film for 2 hrs.

$$\text{E.F.} = \frac{250 \times 2 \times 60}{(20)^2} = \frac{250 \times 120}{400} = 75$$

*Fig. 5. Diagram showing set-up for double-film, single exposure technique for gamma-ray radiography*



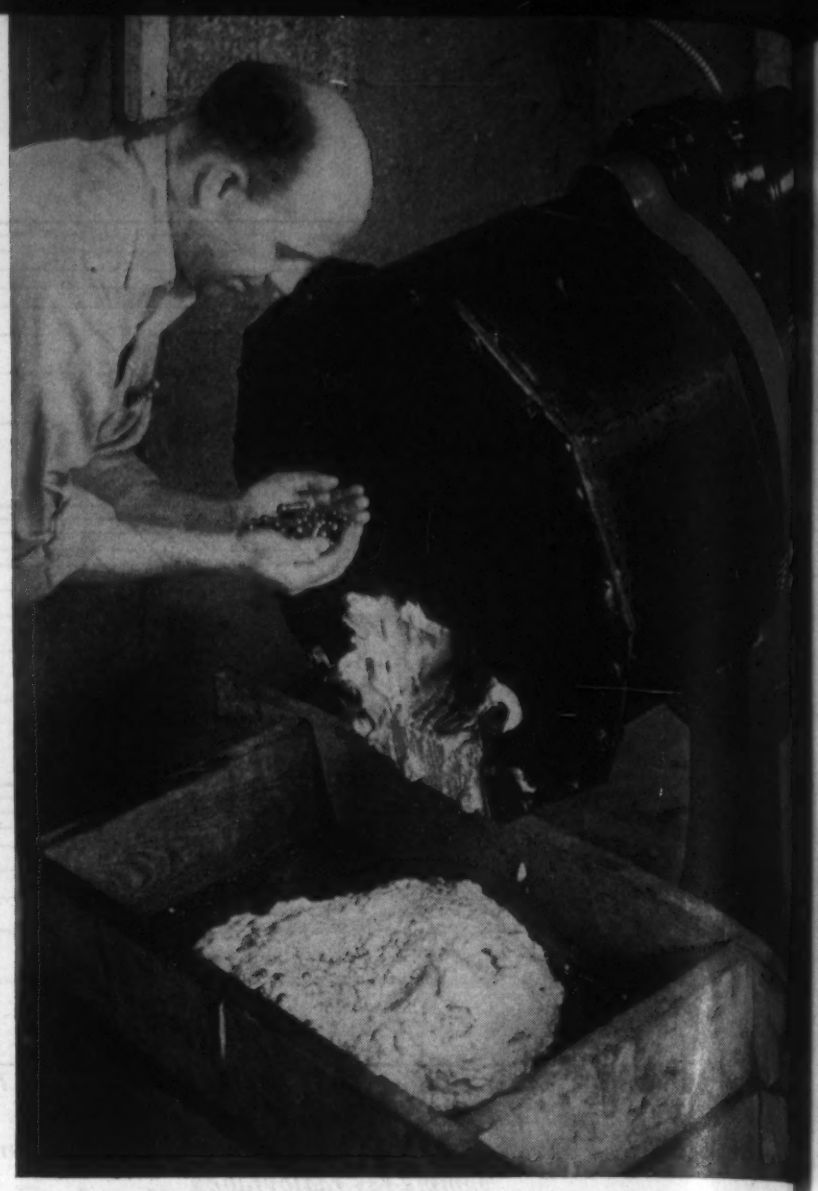
# Barrel Finishing of Metal Parts

## —Tumbling, Rolling, De-Burring and Burnishing

by R. W. MITCHELL *Technical Director*
*Magnus Chemical Co., Garwood, N. J.*

*To speed production and especially to save manpower, castings, forgings, stampings, machined parts and other metal products are increasingly being smooth-surfaced, cleaned or brightened by such mechanical finishing operations as tumbling, rolling, barrel de-burring and burnishing. In this article Dr. Mitchell outlines the nature and fields of application of these four methods of metal finishing and discusses the practical aspects of several specific problems that can be solved by one or more of these methods.*

*—The Editors*



*Barrel de-burring combines many of the features of rolling and burnishing to remove undesirable metal from parts without excessive dimensional change. (Courtesy: Globe Machine & Stamping Co.)*

IN SPITE OF THEIR LONG HISTORY and a wide field of tested applications, the operations comprised in tumbling, rolling, de-burring and ball burnishing have not even yet been given the attention and usage they deserve. Many finishing operations on a wide variety of metals and pieces are being done by less satisfactory (and usually far more expensive) methods where one or more of these processes would be much more effective.

## The Operations Defined

One source of confusion in these operations is a lack of a clean cut understanding of the lines which divide each of these methods from the other. Ball burnishing is nothing like tumbling, except that the work is done in a rotating mechanism. There is actually a radical difference even between tumbling and rolling, while de-burring usually takes on partly the characteristics of both.

*Tumbling* (sometimes called rumbling) is an operation in which the work (usually castings or forgings) is rotated in a barrel, drum or chest together with metal stars, slugs, jacks, punchings, etc., and/or various abrasives, such as pumice, slag, granite chips, sand, etc. The function of tumbling is analogous to snagging or grinding. It removes sand, skin, scale and fins from castings and scale from forgings. It cleans to a uniformly smooth surface, ready for machining and other operations. It does remove a considerable amount of metal and dimensional changes in the work are relatively large.

*Rolling* is similar to tumbling in that the metal parts and abrasives are loaded in a barrel or similar mechanism. It differs materially from tumbling in that the work and abrasives are rolled in such a way that the load rolls over and over upon itself in a continuous flowing motion in relation to the rotating barrel.

The function of rolling is analogous to polishing or "cutting down." Rolling removes flash, wire edges, pits, rough spots, scale, rust, and to some degree, burrs. It cuts down a metal surface to an even and uniform condition. Both tumbling and burnishing tend to remove corners and round-off edges. But the lower degree of dimensional change in rolling is capable of much more accurate control than is the case with tumbling.

*De-burring* is really a special case of tumbling or rolling, with some of the characteristics of burnishing. In other words, the objective here is the removal of metal at a definite location in the work, with as little dimensional change on the balance of the work as possible.

*Burnishing* (which may be self-burnishing or ball-burnishing) is an operation in which the work is given a high finish or lustrous surface by being rolled in a barrel with hardened steel balls (or some modification thereof) or, in some cases without the steel balls, where the load is of such parts that they can be self-burnishing. In either case, however, no abrasive is used. Instead, a lubricant is added for the express purpose of avoiding metal to metal contact, regardless of whether steel balls are used or not.

In other words, in the case of burnishing, metal is *not* removed from the work and dimensional changes do not occur. Burnishing is analogous to buffing in that it puts a high finish on a clean and smooth, but dull metal surface.

Returning now to de-burring, it is possible to set up a self-burnishing operation, in most cases, using a carefully selected lubricant and operating the barrel on the same basis as any other barrel burnishing operation, but with the addition of a suitable abrasive which will take care of the removal of the undesired burrs without causing excessive dimensional changes in those parts of the work where such changes are not desired. The key factor in such de-burring operations is the selection of the proper lubricant and the use of the right kind and size of abrasive, which, in combination, provide the selective "cutting-down" action which is the essence of de-burring.

Thus we see that in tumbling and rolling, metal to metal contact is desirable and dimensional changes over a wide range are expected. In barrel burnishing, metal to metal contact is to be avoided and carefully selected lubricants are required for this purpose. Dimensional changes are taboo. In de-burring, we want to remove metal at certain places and not to remove it at others. We cannot prevent metal to metal contact in one spot and get it at another. So we add a suitable abrasive, counting on the nature and location of the burrs to insure their being cut down, while the lubricant prevents excessive removal of metal elsewhere on the work.

Let us consider these four operations in some detail, with attention to the jobs they can and cannot do—and the variations in procedure which are possible with different metals and different kinds of work.

## Tumbling

Tumbling is the least expensive method of cleaning castings to a uniform smooth surface for machining and other finishing operations. It tends to increase the strength of castings as a result of the peening action which is a part of the tumbling process. This peening evens up the surface and neutralizes internal strains to a material degree. Forgings are frequently tumbled with comparable results.

Tumbling leads to relatively large dimensional changes in the work treated. It is utilized where such changes are permissible and where the "cut" can be considerable without affecting the work. But although tumbling can remove a great deal of unwanted metal, it is often desirable, before tumbling, to remove gross surface irregularities such as sprues, parting fins and the like on an abrasive wheel or belt. Deep scratches and score marks should also be polished off before tumbling. In this way much time is saved and considerable overall savings are realized. There are many cases where tumbling is simply the first of a series of operations, including rolling and/or de-burring and even ball burnishing.

*Discharging a ball-burnishing barrel. (Courtesy: Magnus Chemical Co.)*

*Tumbling not only improves the finish on castings and forgings but peens the surface with benefit to mechanical properties. This is a battery of wet tumbling machines. (Courtesy: The Abbott Ball Co.)*

Tumbling can be either a wet or dry operation (most usually the former). A considerable amount of dirt, finely divided metal particles and abrasives, is generated during the tumbling operation and it is desirable to remove it as much as possible during the operation, to expedite the tumbling action.

In dry tumbling, this is usually accomplished by drawing a large volume of air through the tumbling machine by means of an exhaust blower or fan. The heavy nature of the dirt makes it possible to use a simple type of dust collector on the exhaust air. Where the tumbling is done wet, the amount of "bite" afforded by the abrasive is increased considerably. Up to certain limits the cut is actually in proportion to the amount of water present. Removal of scale from forgings in particular is speeded by the use of various chemicals in the water (oxalic and muriatic acids, acid salts, cyanides, etc.).

## Rolling

As noted above, rolling is also a cutting-down operation, but because of the nature of the process, the "cut" is lighter than that obtained in tumbling, although it can be comparatively heavy, depending on the time and abrasive used. Rolling is applicable to such objects as will form a rolling load in a slowly rotating barrel. This usually means small parts which will not entangle, nest or interlock. Nor should parts that are rolled be so thin in any cross section as to bend readily. Where sharp edges or corners must be held, rolling is a questionable process.

Hollow or drilled pieces from which the rolling abrasive cannot be readily rinsed are not suitable for rolling. In general, rolling is not used on pieces having any one dimension over 6 in. and in usual practice, pieces are much smaller. Long straight work such as curtain rods, tools, handles, etc., which can be rolled with the long axes always parallel are an exception to this rule.

However, rolling offers a most economical method of providing a smooth surface on a virtually infinite variety of designs, shapes and materials in small parts. Compared with the use of wheel finishing, rolling offers such large savings in cost that one would not imagine it possible that the former method could be used today. The fact remains that adequate use of rolling is still, in spite of the war production program, far below what it could and should be.

Rolling is done in either open tilt barrels or closed horizontal barrels. For smaller parts, the tilt barrel is preferable. It can be inclined at different angles for varying effect, since the rolling action increases in intensity as the axis of the revolving barrel is lowered toward the horizontal. An outstanding advantage of the open tilt barrel is the fact that the operator can watch the progress of the work and avoid waste of time or damage due to over-rolling.

## Use of Abrasives and Chemicals

As in the case of tumbling, abrasives are used in rolling. A wide variety of abrasive materials is used, with particle size, hardness and sharpness the determining factors in their selection. When the proper abrasive or combination of abrasives is used to give the required finish, time and power are both saved.

The more commonly used abrasives for rolling are cinders; slag; pumice; sea, sharp or builders' sand; limestone; granite chips; broken glass; Silex; emery; Alundum and Carborundum. Pumice is widely used, for its sharp but light and soft action on brass and soft metals and for finish smoothing. Sand is generally used for steel. Hardened metals require harder, quick cutting abrasives such as emery, Alundum or Carborundum. Where the surface to be rolled is soft, or where a brightening, rather than an extensive cutting down action is desired, milder or finer abrasives are used, such as silica, chalk, lime, crocus, polyroth and rouge. In some cases leather scrap or meal, felt and hardwood sawdust (lignum vitae, maple, boxwood) are also used, sometimes with fine abrasives.

Often sawdust is used to follow an abrasive roll for the purpose of scouring the fine abrasive from the metal surface. It is also used with abrasives as a diluent and spacing agent. Metal tacks, slugs, punchings, scrap, as well as steel balls and steel wool are often added to provide a more uniform rolling action, and to carry the abrasive with a rubbing motion into depressions or corners.

Rolling, like tumbling, can be carried on wet or dry. In most cases, rolling is a wet operation, although in certain operations, notably brightening of screw machine products, dry rolling with sawdust is usually preferable. Wet rolling gives a greater "cut" than dry. For maximum action the amount of water added should be just enough to make a wet paste or mud with the abrasives. Note that water evaporates rapidly during the rolling action and must be frequently replaced.

Chemicals are often added to the water to provide specific effects. Dilute sulphuric and muriatic acids or ammonium chloride are commonly used to aid in scale removal. Alkali and cyanide in small amounts are often added in rolling steel to improve the color, while cream of tartar or cyanide has a similar effect on copper alloys.

Where dry rolling with sawdust is used for brightening screw machine products, very fine sawdust should be used to avoid as much as possible the clogging of threads and slots. Sufficient sawdust should be

*This battery of tilting tumblers with wooden barrels demonstrates the high production possibilities in barrel-finishing. The parts here are being tumbled with sawdust and a suction blower system is attached to each barrel. (Courtesy: The Baird Machine Co.)*

used (several times the volume of the work load) to keep the units well spaced and away from each other and from the barrel surface.

## Rolling Speed

Speed of rolling is another factor which must be considered. As a rule, better results are obtained at around 25 to 30 r.p.m., though the speed may go higher.

The length of time required for a successful roll varies widely. The softer the metal, the faster it is cut down. High finishes, (very bright, smooth, even surfaces) require extra long rolling, starting with a coarse abrasive that is gradually broken down as the rolling proceeds so that the "cut" becomes finer and finer. Rolling is very frequently followed by ball burnishing for a final bright finish.

Average rolling times for various metals are as follows:

| | |
|---|---|
| Brass and bronze castings | 10-15 hrs. |
| Malleable iron castings | 30-40 hrs. |
| Grey iron castings | 70-80 hrs. |

Stampings, automatic screw machine products have widely varying rolling times (from 1 to 100 hours, depending on the quality of the stock, extent of die marks, scoring, rough edges, etc., as well as the type of finish required).

Rolling is in extensive use for preparing metal parts for a final finish in a ball burnishing operation. Steel articles on which a high finish is desired are often given a surface hardening treatment and rolled for upwards of 100 hr., before final ball burnishing for another 100 hr. Hot rolled and pickled stock which is ultimately ball burnished is usually rolled for a preliminary 48 hr.

## Ball Burnishing

Tumbling and rolling "cut" the metal and hence involve dimensional changes. Ball or "self" burnishing removes no metal, but produces a high lustre on a surface by rubbing action in a rolling load. This operation of barrel burnishing has as its objective the production of this high lustre on parts that cannot be so finished (because of size and shape) in any other way, or that can be finished by this method at a lower cost than by hand labor.

Barrel burnishing is often used as a preliminary treatment before plating—and is also used as a finishing process after plating, to improve and even lustre, and to close pores. Since burnishing must have no abrasive or cutting action, abrasives are not used. What is desired is a rubbing pressure that flattens and spreads all minute surface irregularities to as close to a perfectly even surface as possible. Burnishing cannot remove visible surface irregularities, scratches, pits, etc. It will not improve color. These conditions must be taken care of by treatments before the burnishing operation.

Since there must be no actual removal of metal in burnishing, it is obvious that metal to metal contact must be prevented during the rubbing action which produces the burnishing action. Hence it is that in this operation, a new factor appears—the use of a lubricant to prevent abrasion of the metal surface. This use of a lubricant solution is of the utmost importance—and the selection of the right lubricant for each particular type of job cannot be over-emphasized.

The lubricant in ball burnishing not only prevents abrasion due to metal-to-metal contact. It also prevents heating of the load and promotes the development of the high lustre which is the main objective of the process. It might seem that with these functions in mind it should be relatively easy to set up specifications for a single lubricant which would be applicable to all burnishing operations. This is far from the case.

## Selection of a Lubricant

Actually, the selection of a suitable lubricant for a specific burnishing job is usually the most important factor in the cost and quality of the final results. The fact that for almost all burnishing operations soap makes the most suitable lubricant does not make the problem easier, because of the great variety and combinations of soaps that can be used.

There is no classification of soaps from the burnishing lubricant viewpoint. In some cases the nature of the metal being burnished makes it desirable that the solution be more readily rinsable than in others. This factor of rinsability is of great importance where the burnished work is subsequently plated. The ability of a burnishing compound to keep the dirt in suspension during the burnishing operation is often a very important factor in speedy, effective and economical burnishing.

There are specially compounded burnishing soaps to meet almost every conceivable combination of factors. There are soaps, for example, capable of imparting an extra high lustre in burnishing brass. There are others designed to work in hard waters of various types and to prevent the formation of black scum on burnishing balls. There are special mixtures of soaps with particular qualities for burnishing steel, stainless steel, nickel, silver, brass or aluminum.

There is no specific formula for the selection of a burnishing lubricant, and it is necessary to emphasize

the proper selection of lubricants, because of the feeling on the part of many operators of ball burnishing processes that any soap will do a good job.

In general, two volumes of burnishing agent are used to one of work, but the proper ratio on any particular job is affected by the type of barrel used, the degree of fullness at which it is operated, and the form of the work. It is the weight of the burnishing medium which provides the rubbing pressure. There must be ample balls or other shapes to completely space off and surround each individual piece of work. Hollow or recessed work requires a larger proportion of burnishing medium than solid articles. Stampings require more balls than castings or forgings. It is always safer to use too many balls rather than too few.

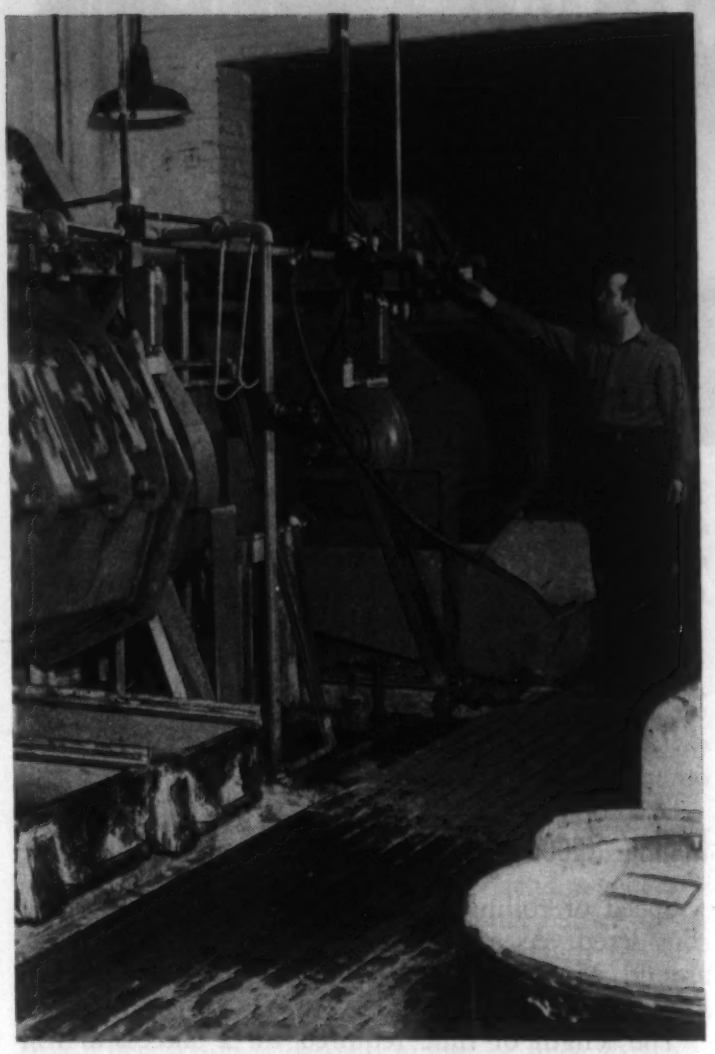
Corners and angles cannot be burnished by any ball, however small. Balls cannot enter angles, slots and indentations smaller than their own diameter. In such cases, or in those where the work is figured, other shapes are required. There is a great variety of specially shaped pieces, such as slugs or diagonals, cones, ball-cones, fin-balls, pins or "oats" which are designed to burnish angles, corners, grooves and other depressions. These forms are generally used in admixture with balls, the assortment in use depending on experience and/or experiment. Too high a ratio of pins or "oats" may lead to a stippling effect on flat work.

## Size of the Burnishing Medium

The size of the burnishing medium is also important. Small balls or units provide more contacts, but deliver lighter rubbing action. From the economy angle it is desirable to use the largest units which will give the required results. Usually this situation is straddled by mixing two sizes of units. In general, the size range in burnishing balls is from ⅛ to ¼ in.

Burnishing balls and other elements are carefully worked to be mirror smooth. Their effectiveness in burnishing is in direct proportion to the degree to which this finish is maintained after they are put into use. In many cases, balls may be kept clean and bright at all times, where the nature of the burnishing soap used is such that it will also tend to keep lime soaps from forming, or prevent deposition of dirt coatings on the balls. In other cases the soap which gives the best burnishing results may not act in this way on the balls. Here it is necessary to clean the balls separately.

Since barrel burnishing cannot remove metal or take out surface blemishes, it is obvious that metal surfaces which are to be burnished must have careful pre-treatment. To get a good surface for burnishing, the work must not only be smooth, but it must also be clean of all dirt, rust, stain and tarnish. As a rule this is best accomplished by a preliminary rolling. Sometimes it is desirable to brighten the work prior to burnishing by the use of such chemicals as muriatic acid (for steel and iron) and sulphuric acid for copper and brass. Where the work is not too dull to start with, a brightening effect may be obtained in the burnishing barrel by adding a small amount of cyanide to the barrel. This applies mainly to brass and steel.



*The Roto-Finish process, two machines for which are shown in use at a large midwestern plant, is a method of barrel de-burring of metal parts. (Courtesy: The Sturgis Products Co.)*

In starting a burnishing operation, the load of work and balls is just covered with water and the lubricant added. Sufficient lubricant should be used to build and hold a heavy cushion of suds throughout the run. This averages 4 oz. to each 100 lb. of work. The harder the metal surface, the higher will be the finish it can take. Many parts to be finished by burnishing are especially hardened for the purpose. It takes longer to get the desired finish on harder surfaces, but higher quality and more permanent surfaces result. This does not mean that high lustres cannot be developed on soft surfaces and soft metals. The use of small balls and low speeds to avoid excessive rubbing pressure will give a satisfactory finish, even to die castings. Brass, nickel and soft nickel plated surfaces can be brought to an excellent lustre by the use of the proper combination of lubricant, balls and burnishing procedure. Chromium plated parts require extra burnishing time, due to the hardness of that metal.

## Speed of the Barrels

Barrel speeds must be adapted to the nature of the work—(size, shape, softness, fragility). They also depend on the diameter of the barrel. The smaller

the diameter of the barrel, the faster the allowable speed. Small pieces that roll freely without scratching can be burnished at a much higher rotation rate than flat and large pieces which would scratch or nick at high speeds. Too great pressure may develop at higher speeds where soft metals are concerned, leading to deformation of the surface. Small or regularly shaped pieces can usually be run faster than large or irregularly shaped parts. It is obvious that pieces with edges and sharp corners must be run slowly.

For mild burnishing action on light work a 24 to 30-in. barrel should run at about 15 r.p.m., reduced to 10 to 12 r.p.m. for die castings. On substantial steel or brass pieces speeds up to 45 r.p.m. can be used for a vigorous burnishing action, as long as no scratches, dents or peen marks show up on the work. Note, however, that if the rate is too slow, the work slips down the side of the barrel without being carried high enough to give the required rolling action. Ten to 12-in. barrels are usually run from 35 to 80 r.p.m. while 16-in. barrels are run 30 to 50 r.p.m. Small diameter barrels are ordinarily run nearly filled. Larger barrels are run 2/3 to 4/5 filled.

Burnishing time, consistent with obtaining the required finish, is the most important factor in barrel burnishing. The speed, size and kind of burnishing agent and above all, the burnishing lubricant should all be experimented with on any new burnishing job, so that the best conditions are set-up to give the desired finish in minimum time. It cannot be too strongly emphasized that the choice of the proper speed, medium and lubricant can effect startling economies in burnishing time.

## De-Burring

The operation of removing undesirable metal from parts without excessive dimensional changes on other surfaces of the parts is of the greatest importance, in that where the work is done manually with files or other tools, the cost may mount to very high levels. If it is possible to de-burr any parts in bulk by some sort of selective rolling or tumbling action, savings are really enormous as opposed to manual operations.

War production in particular has introduced de-burring problems which are different from those faced before the war. Today, in addition to casting burrs, screw-machine burrs and just sharp edges, we are faced with very definite burrs from cutting, machining and stamping operations which have to be carefully removed from work which must be held to very close tolerances and which in many cases cannot be treated with chemicals for various reasons. A great many of these problems can be solved in a barrel in which a combination of some of the features of rolling and of burnishing could de-burr many pieces without excessive or undesirable dimensional changes on other parts of the work

In one plant making aircraft engines one special nut was being de-burred by hand filing at the rate of 12 per girl-hour. Barrel de-burring with agate pebbles gives 1200 per hr. An engine part manually filed at the rate of 5 per hr., with considerable spoilage from filing slips, was run up to 175 per hr. with no rejects, by barrel de-burring. Washer de-burring was run up from 45 to 5000 per hr. The ratio of output increase per operator can usually be figured about 100 to 1.

This does not mean that all work that has to be de-burred can be processed in a barrel. Some pieces are too large or have too many delicate or close tolerance features. But there are a great many pieces which can be de-burred in barrels, once careful experimentation has determined the speeds, abrasives and above all, the lubricants which will produce the results.

The rolling action utilized in this method of de-burring, together with the protection against metal to metal contact provided by the addition of a suitable lubricant, limits the "cut" of the abrasive to projecting burrs, while other surfaces which tend to rub each other in passing are prevented to a large extent from contact and abrasion by the lubricant. Some work has been de-burred in rolling operations in a sand-water mix. De-burring by this method is slow and there is a danger of pitting the work.

## Use of Oils and Abrasives

Some satisfactory results have been obtained by the use of oils and abrasives, such as sand, Alundum, emery or Carborundum. This method is applicable to a considerable variety of relatively small burrs, particularly when, instead of a mineral oil, a suitable solvent soap lubricant is used which, in addition to giving better protection to the surfaces where dimensional changes are not desirable, also insures easy, speedy and thorough removal of the lubricant and metal particles after de-burring without the use of special washing procedures. Recent applications of this solvent soap type of lubricant with granite chips as the abrasive material have given very satisfactory results in the short-time de-burring of parts for aircraft, and fighting equipment, both in steel, and aluminum alloys.

There is no formula for barrel de-burring, any more than there is for rolling or ball burnishing. The only procedure that can be followed is experimentation, based as far as possible on experience—or, if that is lacking, on trial and error. Certain objects automatically drop out of this particular picture because of their size, shape or the extent of the burrs to be removed. But where the parts can be rolled or tumbled and where the burrs are not too heavy, it will pay any plant to put the problem of the proper combination of abrasive, lubricant and barrel speed up to the manufacturers of burnishing compounds with the objective of seeing what can be done in barrel de-burring. For if a successful combination can be found, the savings possible are very much worth while.

The chances are that if you are producing work which requires a high finish, you are already familiar with what can be done with ball or self-burnishing, but if you have problems involving the removal of sand, skin, scale, fins, flash, wire edges, pits, rough spots and, most particularly, burrs, you should make a careful study of the results you may obtain by tumbling, rolling and barrel de-burring, particularly if you are now spending any considerable amount of time and labor on manual methods.

# Contoured-Cavity Shell Forging

## —A PICTORIAL STORY

MATERIAL AND TIME are being saved in the shell-production program through the use by several manufacturers of forging in place of machining to form the cavity of the projectile. Various shell-forging methods have been described in articles in M&A during the last three years, and some have been similar to the process pictorially presented herein; the present description is of particular interest because of the large caliber projectile involved and the excellence of the photography.

The plant whose up-to-date methods are portrayed here is Porter-Blairsville Co., Blairsville, Pa., a subsidiary of H. K. Porter Co., Inc. of Pittsburgh. Formerly they were fabricating these large-caliber Navy shells by producing straight-cavity forgings and then machining to achieve the desired contour. In the method now in use a shaped punch is employed to produce a "contoured-cavity" forging, flaring out in size from the closed to the open end of the forging.

Some of the advantages of the contoured-cavity method over the straight cavity method as outlined by John C. Norman, general manager of Porter-Blairsville Co. are as follows: Because the contoured cavity is of larger diameter, larger punches and mandrels are used, which give better rigidity and wear in operation. This tends to produce more concentric forgings and to give better tool life. Also, because of the larger diameter mandrel used in the draw bench, there is less tendency for the base to punch through in drawing than with the smaller mandrel used for straight-cavity forging.

Much less machining is required, since the required taper has been produced to a large extent in the forging process. In this feature alone, the contoured type forging has reduced the metal required per unit approximately 13%, which constitutes a valuable saving of critical shell steel. This means that over nearly two-thirds of the length of the shell, the amount of metal to be turned from the outside diameter has been reduced by almost an inch.

This reduction has increased the effective capacity of the company's rough-turning lathes 35%. Also, because of the lighter cuts required, the life of carbide cutting tools in this operation has been increased by an even greater percentage.

*Square shell-steel bars, cut to billet size, are first heated in billet heating furnaces. A hot billet is seen here leaving the furnace on a roller conveyor.*

*Billets are next pierced. This photo shows the die holder above the billet after piercing has been accomplished.*

*The hot slug is then moved on a conveyor (shown at the right) to the basket of the shell-drawing press and is ready to be drawn through the press's 5 ring dies.*

*The finished shell forging emerges from the draw bench.*

*Shell lathes machine the outside surfaces, no machining being required on the cavity. Here the shell forging is undergoing the first rough-turning operation.*

*Finally the nose end of the forging is heated and the nosing is accomplished in a hydraulic press. Here we see the nosed shell at the end of this operation.*

# Basic Refractories for the Copper Industry

## Part 2

*The first part of this article, published in our May issue, covered basic refractories in copper reverberatory furnaces. This section is devoted to basic converters.* —*The Editors*

by R. P. HEUER AND A. E. FITZGERALD

*General Refractories Co., Philadelphia*

### Basic Converters—the Tuyere Zone

The basic converter has been a practical success for about 35 yr. The basic lining has proven a great economy over the acid lining formerly used. Operating requirements of basic converters vary a great deal and each converter operation must be adjusted to yield the best overall results. This may not necessarily insure the longest life or the lowest cost on refractories. Thus, very few, if any, converter operations are alike in every respect and this is reflected in the variable life obtained on linings and the refractory cost incurred.

The major refractory maintenance on the converter is the "tuyere section" or "back." This area is that within the shaded border in Fig. 2. Some repairs are not extensive and may cover only the area immediately around the tuyeres and a few courses above. The bricks or shapes immediately around the tuyeres are exposed to a maximum of abrasion, slag attack, thermal and mechanical shock, and structural strain. The extent to which each contributes to the ultimate failure has not been established. This varies in different operations or even from one campaign to another in the same operation.

Two general types of tuyere zone construction are used. In one there are no close fitting special shapes surrounding the tuyere pipes. Where no special shapes are used, the tuyere pipe is inserted in the opening formed by the surrounding brick. This hole is square or rectangular and the space not filled by the round pipe is packed tight with granular refractory material. This practice is limited and most of the tuyere zones are built with special shapes which fit closely around the pipe.

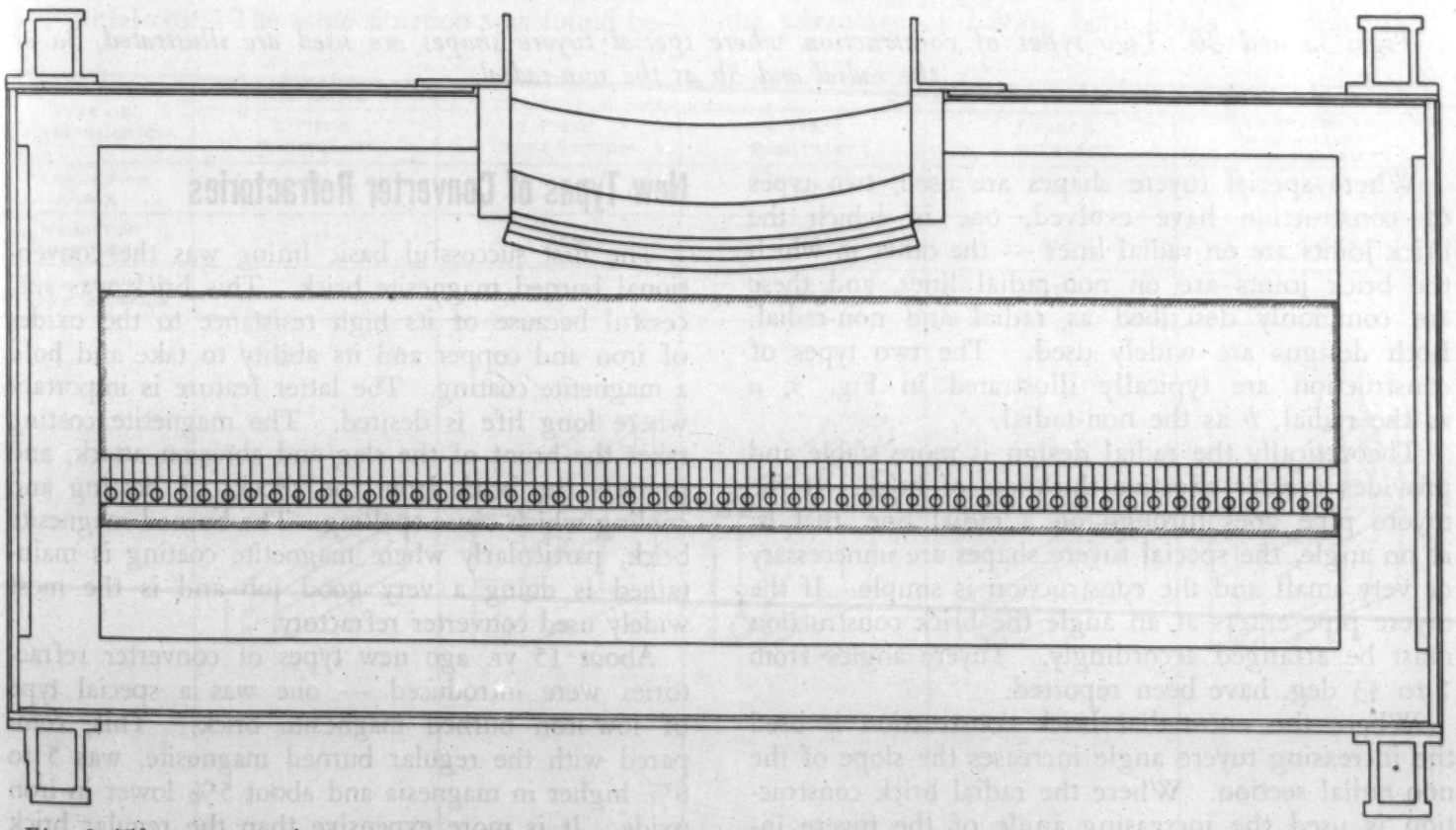
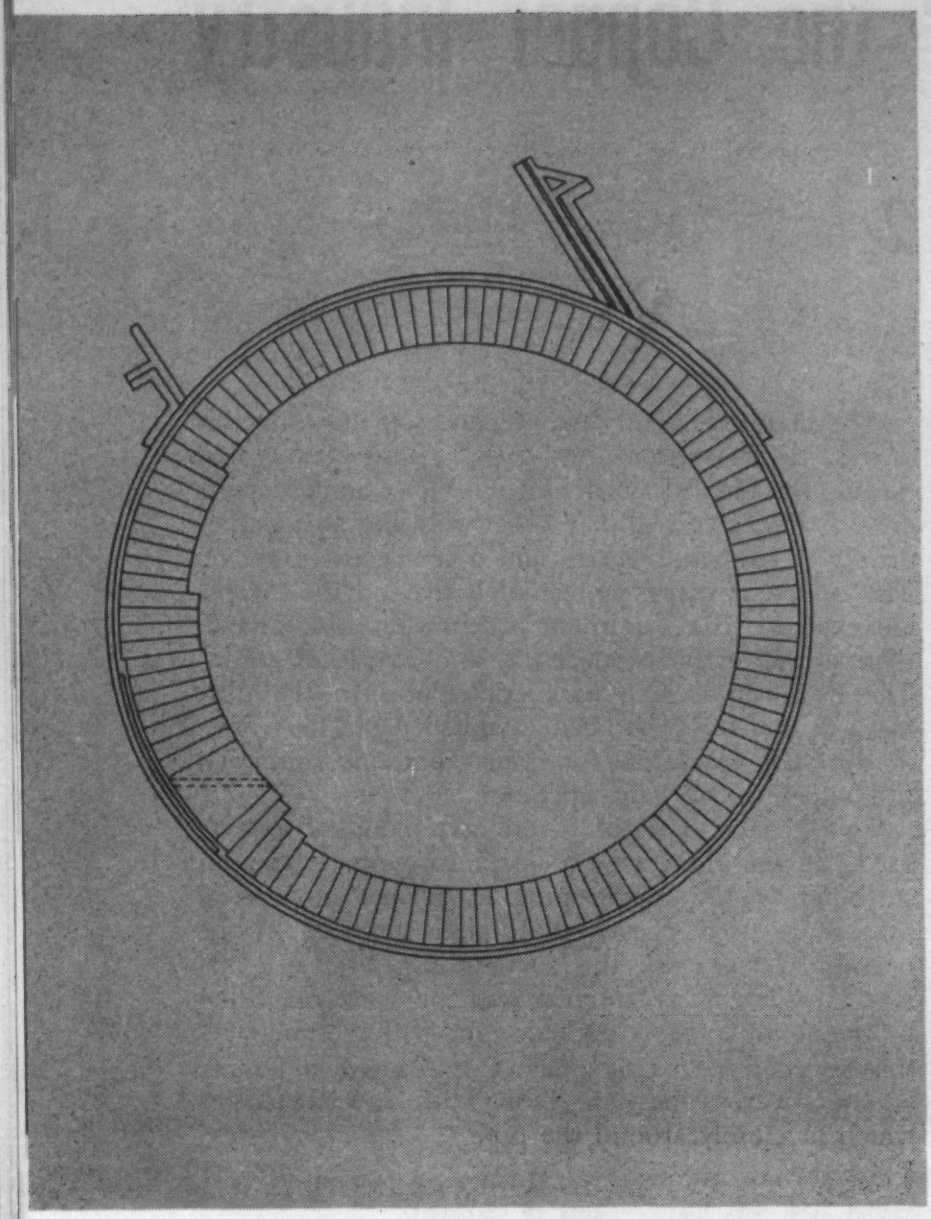
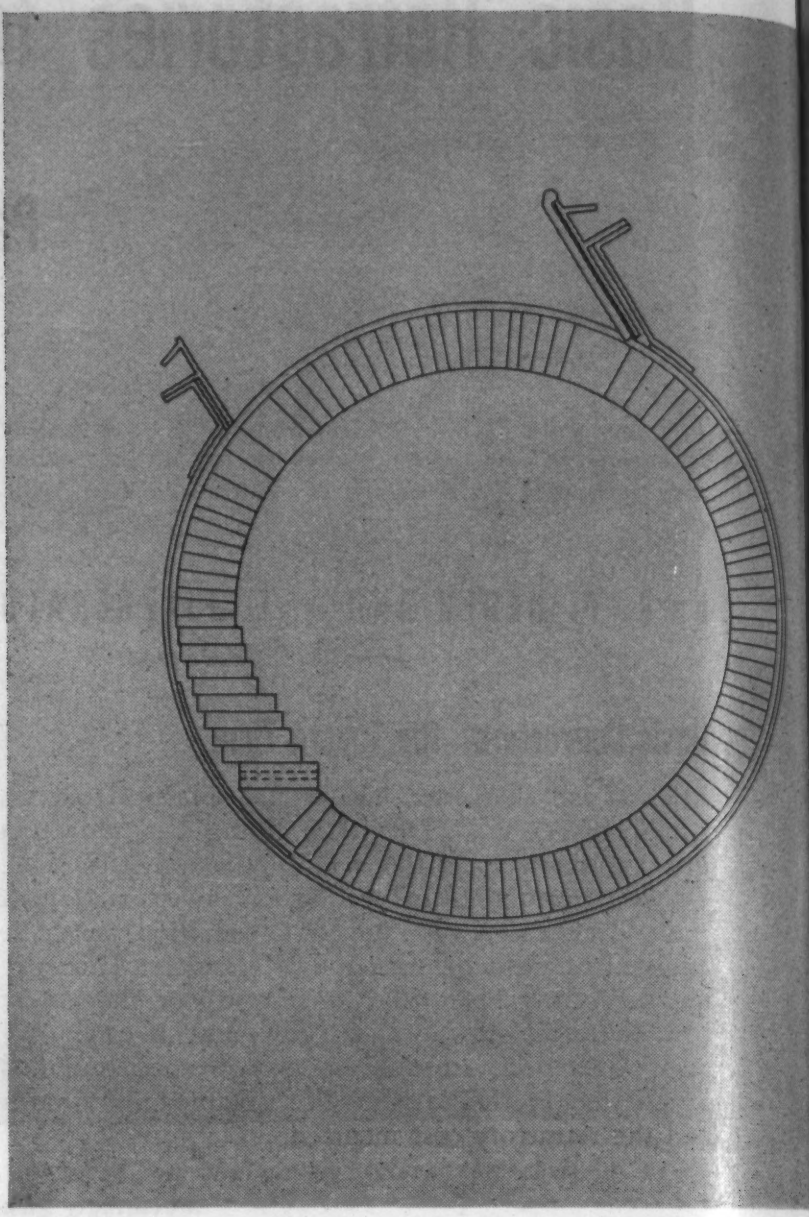


*Fig. 2. The major refractory maintenance on the converter is the "tuyere section" or "back." This area is that within the shaded border.*





*Figs. 3a and 3b. Two types of construction where special tuyere shapes are used are illustrated, 3a as the radial and 3b as the non-radial.*

Where special tuyere shapes are used, two types of construction have evolved, one in which the brick joints are on radial lines — the other in which the brick joints are on non-radial lines, and these are commonly described as radial and non-radial. Both designs are widely used. The two types of construction are typically illustrated in Fig. 3, *a* as the radial, *b* as the non-radial.

Theoretically the radial design is more stable and provides greater effective thickness of brick. If the tuyere pipe goes through on a radial line, that is, at no angle, the special tuyere shapes are unnecessary or very small and the construction is simple. If the tuyere pipe enters at an angle the brick construction must be arranged accordingly. Tuyere angles from 7 to 33 deg. have been reported.

Where the non-radial brick construction is used the increasing tuyere angle increases the slope of the non-radial section. Where the radial brick construction is used the increasing angle of the tuyere increases the size and number of the tuyere shapes. Fig. 4 illustrates various types of tuyere construction.

## New Types of Converter Refractories

The first successful basic lining was the conventional burned magnesite brick. This brick was successful because of its high resistance to the oxides of iron and copper and its ability to take and hold a magnetite coating. The latter feature is important where long life is desired. The magnetite coating takes the brunt of the slag and abrasion attack, and protects the brick from the shocks of heating and cooling which cause spalling. The burned magnesite brick, particularly where magnetite coating is maintained is doing a very good job and is the most widely used converter refractory.

About 15 yr. ago new types of converter refractories were introduced — one was a special type of low-iron burned magnesite brick. This, compared with the regular burned magnesite, was 5 to 8% higher in magnesia and about 5% lower in iron oxide. It is more expensive than the regular brick because of the special magnesite used in its manufacture.

Only limited use has been found for this low iron burned magnesite product.

Another innovation was a monolithic lining in which low iron magnesite was rammed by special method and dried in place. The lining is described by Fowler[11] and Parson[12]. It has been more satisfactory than burned magnesite brick when used in Great Falls converters.

The other newly introduced converter refractory is the chemically bonded magnesite brick. This brick displaced burned magnesite in a variety of operations, for example, in the treatment of low grade matte where magnetiting was practiced, also for high grade matte in conjunction with magnetiting and for the combination of matte and copper scrap with no magnetite coating protection.

Several years ago chrome-magnesite brick were proposed as a possible converter refractory. These brick are available in two types, burned and the unburned. They cost less than burned magnesite brick. Chrome-magnesite bricks were first tried, as would be expected, in operations where costs were high and life was short. An initial comparison was made with the burned magnesite brick in small converters or the larger converters where thorough magnetiting could not be done or was not considered feasible. In these trials the chrome-magnesite did not necessarily last longer than burned magnesite but was found preferably due to lower cost.

A somewhat similar situation exists between the burned chrome magnesite and the unburned brick. Comparative trials of the two brick show no substantial difference in the life obtained but a saving results by the use of the unburned brick due to its lower initial cost. The same situation was found between unburned magnesite and chrome-magnesite brick in operations handling matte and scrap and operating without benefit of the protective magnetite coating. Unburned chrome magnesite brick did equally well and cost less.

As this is written the situation where the protective magnetite is fully maintained is not so clear. It has not been definitely established that the chrome-magnesite will take and hold a coating as well as burned magnesite brick. If unable to take the coating the chrome-magnesite will likely prove inferior. Failure to hold a coating is believed to have been the reason for some unsuccessful trials of chrome-magnesite.

If the coating can be maintained the chrome-magnesite brick should prove superior, or at least preferable due to its lower cost. This point is under more detailed investigation. There is a further possibility that a combination lining of magnesite and chrome-magnesite brick may be desirable, or an entirely new refractory embodying the desirable qualities of each of these brick can be developed. This can only be determined by further experimental work.

## Evaluating the Various Types

Accurate evaluation of the various types of converter refractories must be made in the field in actual service. A common method of comparing two refractories A and B is illustrated in Fig. 5. Linings frequently wear out faster in one side than in the other and a check run is usually made reversing the position of A and B.

Another method is illustrated in Fig. 6. This has the advantage of having both kinds of refractories

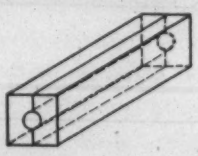
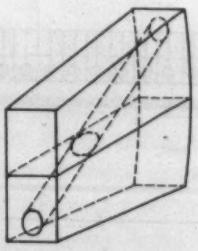
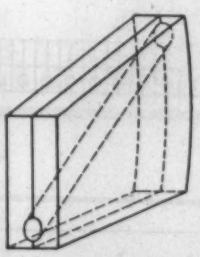
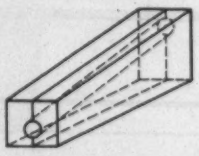
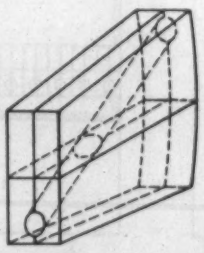
| TYPE OF CONSTRUCTION | NON-RADIAL | RADIAL | | | |
|---|---|---|---|---|---|
| | 2-PIECE RIGHT & LEFT | 2-PIECE TOP & BOTTOM | 2-PIECE RIGHT & LEFT | 2-PIECE RIGHT & LEFT | 4-PIECE TOP-RIGHT & LEFT BOTTOM-RIGHT & LEFT |
| TUYERE PIPE ANGLE | 30° | 30° | 30° | 7° | 30° |
| WEIGHT OF EACH PIECE | 27° | 92° | 92° | 33° | 46° |
| TOTAL WEIGHT OF TUYERE ASSEMBLY | 54° | 184° | 184° | 66° | 184° |
| |  |  |  |  |  |

*Fig. 4. Various types of tuyere construction are illustrated by this drawing.*

in both sides of the converter, thus testing A and B under a wider variety of service conditions. In making these tests the usual measurements of tuyere wear are made at intervals and a plotted record kept. This procedure indicates when the wear occurs and such information is frequently valuable.

For instance, one of the refractories under test may wear very rapidly in the early part of the campaign but very slowly thereafter. This might be due to spalling on heating up a new lining and a different heating-up procedure would increase the life. Rapid wear during some given period might be linked up with conditions known to exist during that period. These methods of testing, combined with close inspection at the completion of the run, can do much to evaluate refractories and determine which is best suited to the operating conditions involved. *(To be continued)*

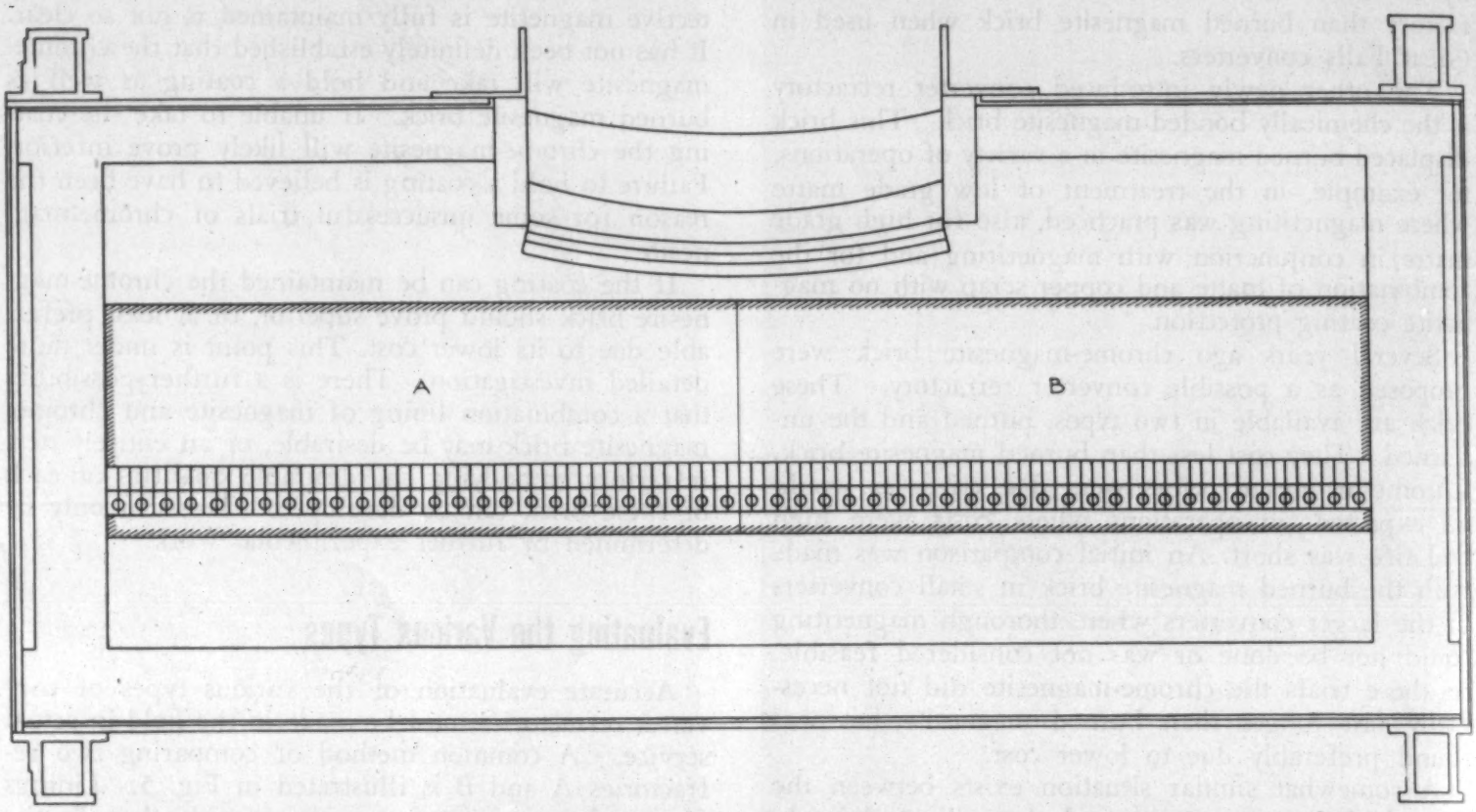



*Fig. 5. Represents a common method of comparing two refractories designated as A and B.*

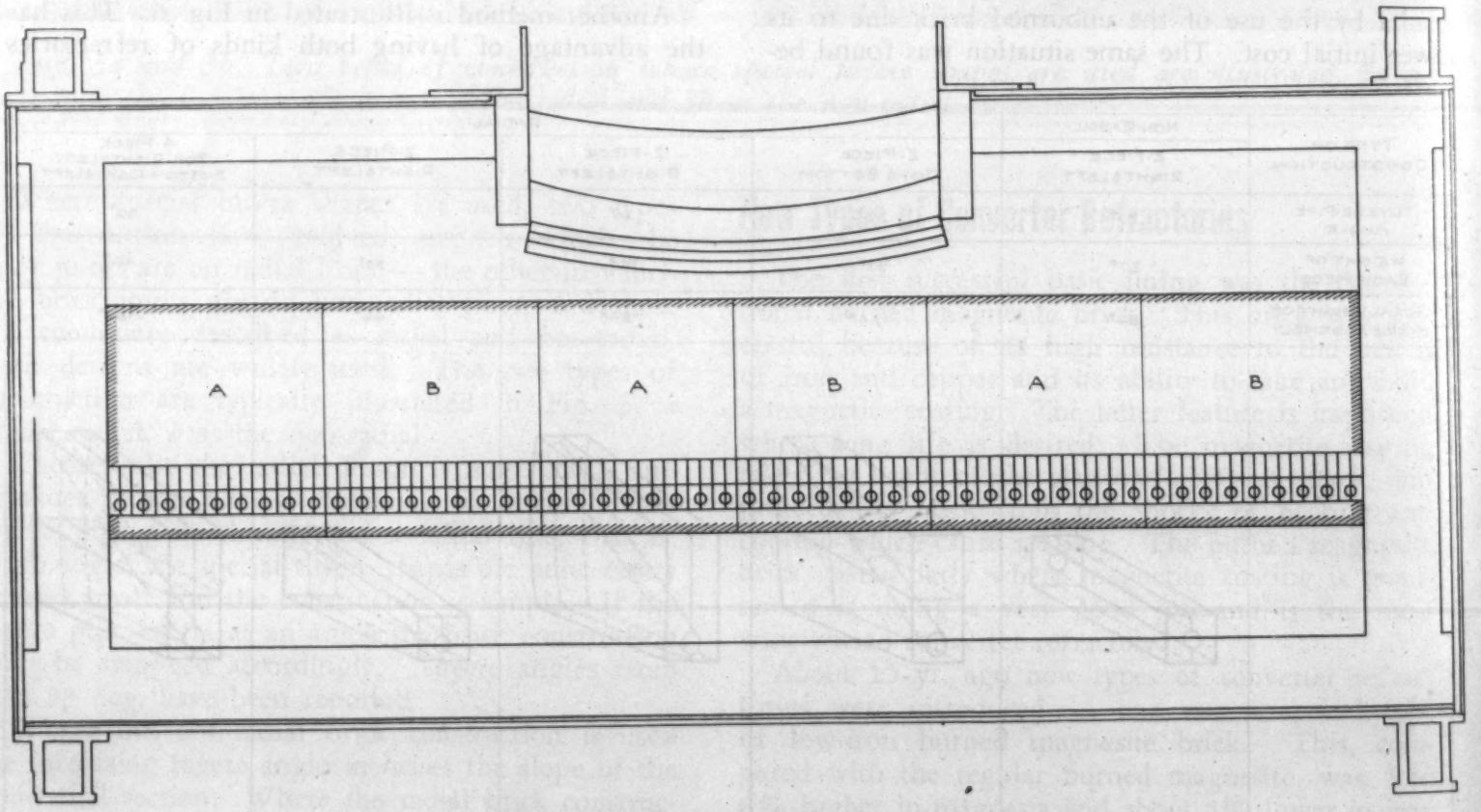



*Fig. 6. Another method of comparing two refractories.*

# Megacycle Induction Heat for Thin Cases

THE SECOND IN A SERIES ON INDUCTION HEATING

*Most recent of all developments in the induction heating field and one whose post-war possibilities have yet to be fully explored is the use of frequencies higher than 1,000,000 cycles (1 megacycle) per sec. for metal treatment. Such ultra-high frequencies seem to have particular value for the production of very thin "cases," using the mass of cold underlying metal as the quenching medium rather than externally applied water. The properties of such cases, the operating factors involved and some typical applications of megacycle induction heating are described in this article.*

*—The Editors*

**by V. W. Sherman**

*Manager, Industrial Electronics Div., Federal Telephone and Radio Corp., Newark, N. J.*

THE USE OF HIGH FREQUENCY ENERGY for induction heating of steel is not new. In 1898 spark gap equipment was described by Nikola Tesla writing in the magazine *Electrical Engineering*. In 1925, vacuum tube equipment for induction heating was described in a U. S. Patent. Motor generator and spark gap type equipment has been in industry for many years. Vacuum tube induction heating equipment for industry began to appear about 10 yr. ago. Its introduction was regarded as an experiment. However, since 1940, there has been a rapid acceleration in the industrial usage of electronic heat. It is now as much an accepted industrial tool as are welding control, plating rectifiers, etc.

The fundamental requirement of induction heat is the use of alternating current. It therefore follows that induction heating can be accomplished with any frequency from the commercial 60 cycles up to millions of cycles per second. There are three recognized types of induction heating equipment and there is a direct relation between the type of equipment, its practical frequency range, and the heating jobs it is best suited to perform. The fields of use of these three types—motor generator sets, spark gap converters and vacuum tube units—were discussed in a group of articles in the May issue of METALS AND ALLOYS.

The vacuum tube unit is used for frequencies from 350 thousand cycles up to over a hundred million cycles per second. For induction heating purposes, frequencies between 350 kilocycles and 15 million

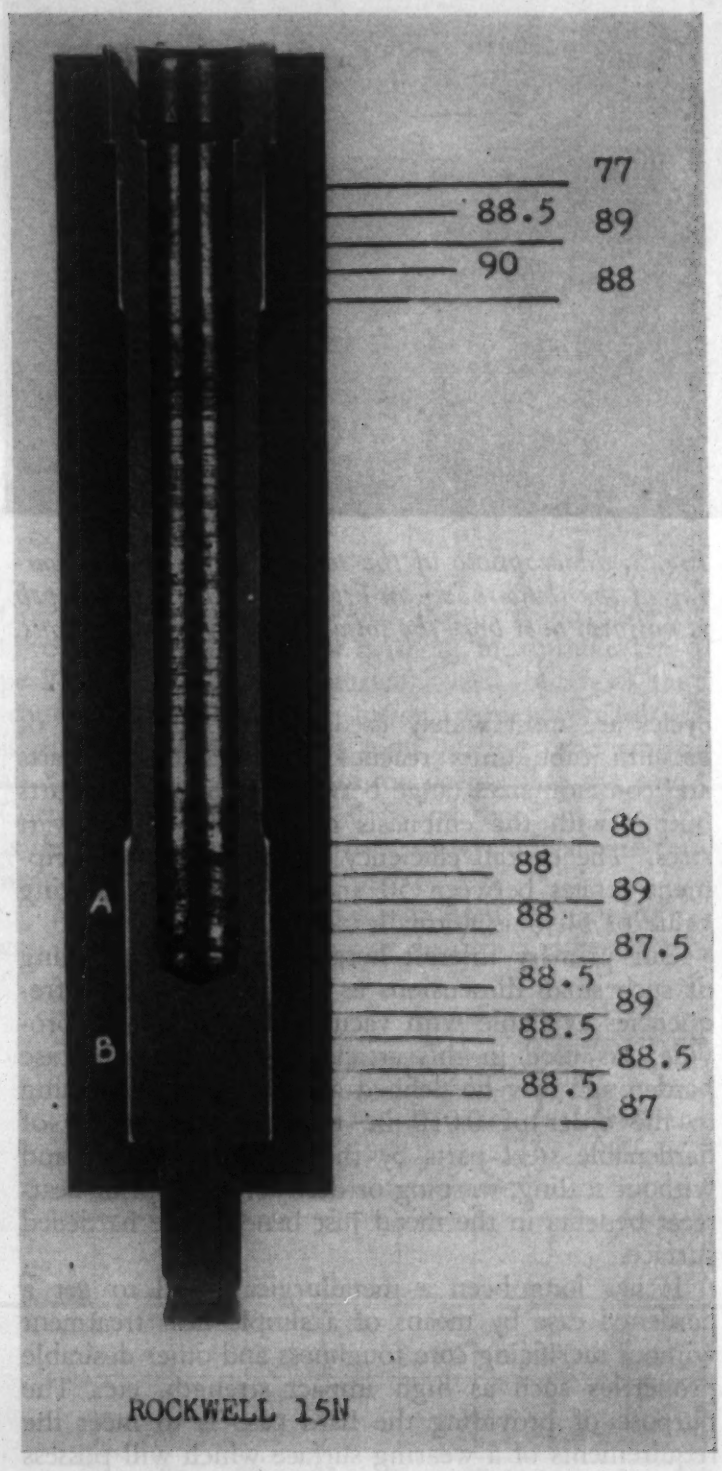



*Fig. 1. Hardness record of a gun synchronizer shaft (about 6 in. long) surface-hardened to a depth of 0.020 in. by induction; the white edge is the hardened area. A maximum hardness of 88 Rockwell 15 N (about 55 Rockwell C) was developed.*

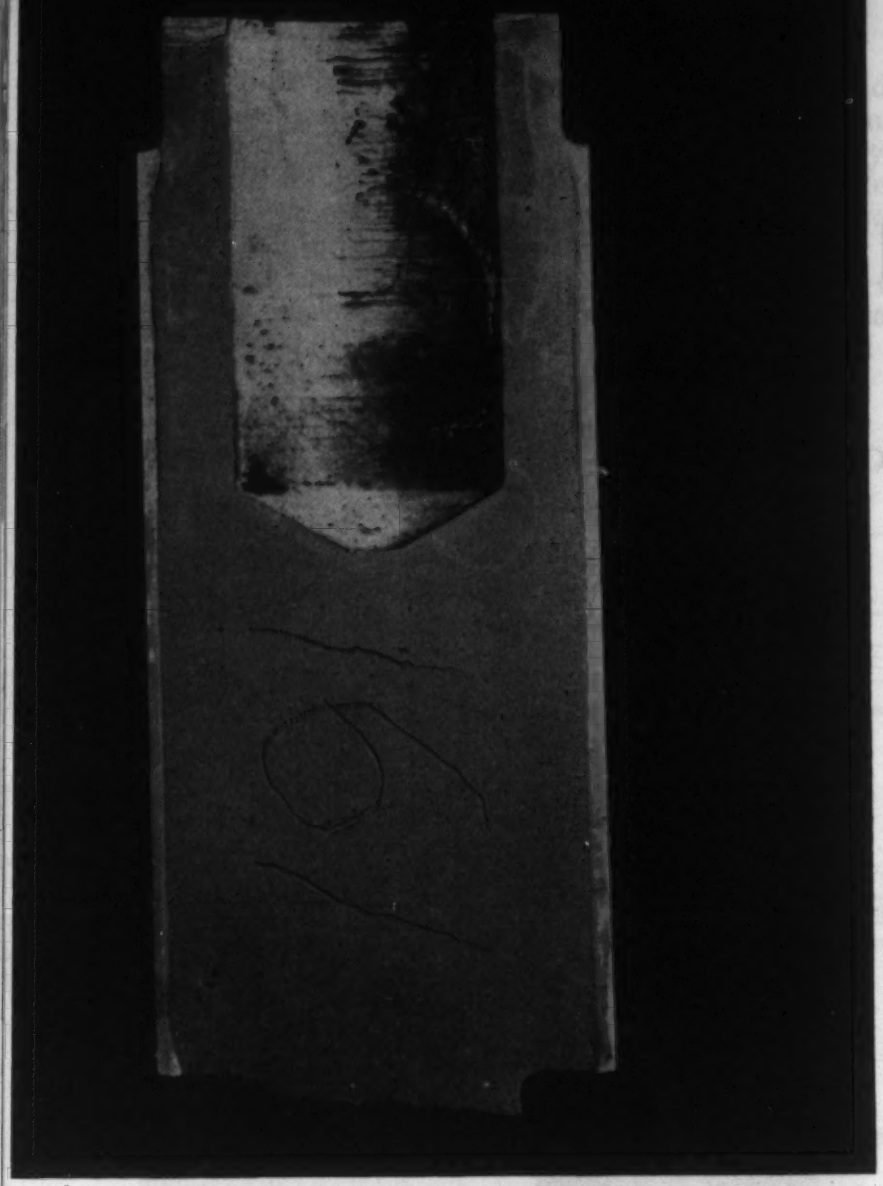


*Fig. 2. Macrophoto of the section of the lower bearing of the shaft shown in Fig. 1. The hardened depth is uniform over both the solid and the hollow portions.*

cycles are most widely used. The power output of vacuum tube units reaches hundreds of kilowatts and common sizes range between 5 and 50 kilowatts output with the emphasis on 25 and 40 kilowatt sizes. The overall efficiency of vacuum tube equipment ranges between 50 and 60%, and a working value of 50% is normally depended upon.

Our primary interest here is *thin* case hardening of such small dimensions as only the very high frequencies available with vacuum tube units can provide. As used in this article the phrase "thin case hardening" may be defined as the surface hardening to the order of 0.010 in. thick on the surface of hardenable steel parts by the use of heat only and without scaling, warping or destruction of prior-heat-treat benefits in the metal just beneath the hardened surface.

It has long been a metallurgical ideal to get a hardened case by means of a simple heat treatment without sacrificing core toughness and other desirable properties such as high impact strength, etc. The purpose of providing the hard case is to meet the requirements of a wearing surface which will possess maximum tensile strength and hardness. It is also desirable in creating this hardened surface to leave it in a state of compression so that it may have maximum fatigue life.

## The Field for Megacycle Heating

With the advent of aircraft engine parts and other production items requiring accurate and thin case hardening, without sacrifice of reliability and toughness in the core, the need for megacycle energy (a.c. frequencies of millions of cycles per second) became apparent. A number of accompanying illustrations demonstrate hardened cases of 0.007, 0.010, 0.020 in., etc., that have been created without disturbing the metallurgical properties of the adjacent internal layers, and the associated hardness data are also given. The secret of the process lies in the use of megacycle energy at sufficiently high power to accomplish the heat treatment in 1 second or less.

There are two ways of securing a hardened case after induction heating—two thermal methods—and it is important to recognize the difference between them. In the first method, a quench is secured by rapidly extracting heat from the surface *outward* into an external coolant. In the second method, a quench is secured by rapid heat flow *inward* from the surface layer to a cold internal core.

The first method is associated with slow-speed low-frequency induction heating. Thirty seconds or more heating time is used. During this time, much of the core is heated hot enough and long enough to suffer tempering and general loss of prior heat treat benefits. The core has become too hot to provide self-quenching of the surface. An external quench must be used and continued until all the stored heat has been gradually drawn out through the surface layer into the coolant. It must be recognized that, by this method, the surface hardness becomes the resultant of two thermal processes:

(1) The surface is rapidly quenched and maintained at a low temperature by contact with the external coolant; but

(2) For an appreciable time the metal just beneath the surface is supplied with replacement heat from the internal core at substantially the same rate as it is losing heat through the surface layer into the coolant. The depth of the hardened case which results will therefore depend not upon the condition of heating, but rather upon *the condition of cooling which involves the mass and geometry of the part.* These are factors beyond the control of the operator. The net result is often a non-uniform and excessively deep case together with a badly tempered core.

In the second method for getting a hardened case after induction heating, only the surface metal is heated and the quenching of this surface layer is accomplished either entirely or in a large part by the cold core just beneath the surface layer of heated metal. This is the method and result associated with high-power megacycle heat using vacuum tube units at a frequency of 2 million to 15 million cycles per second.

With the energy concentrated into a paper-thin surface layer, and with this energy developed in as little as 1 second or less, there is not time for an appreciable amount of the surface heat to be conducted into the core. The depth of the hardened case is controlled by the condition of heating and not by the condition of cooling. The case depth is therefore

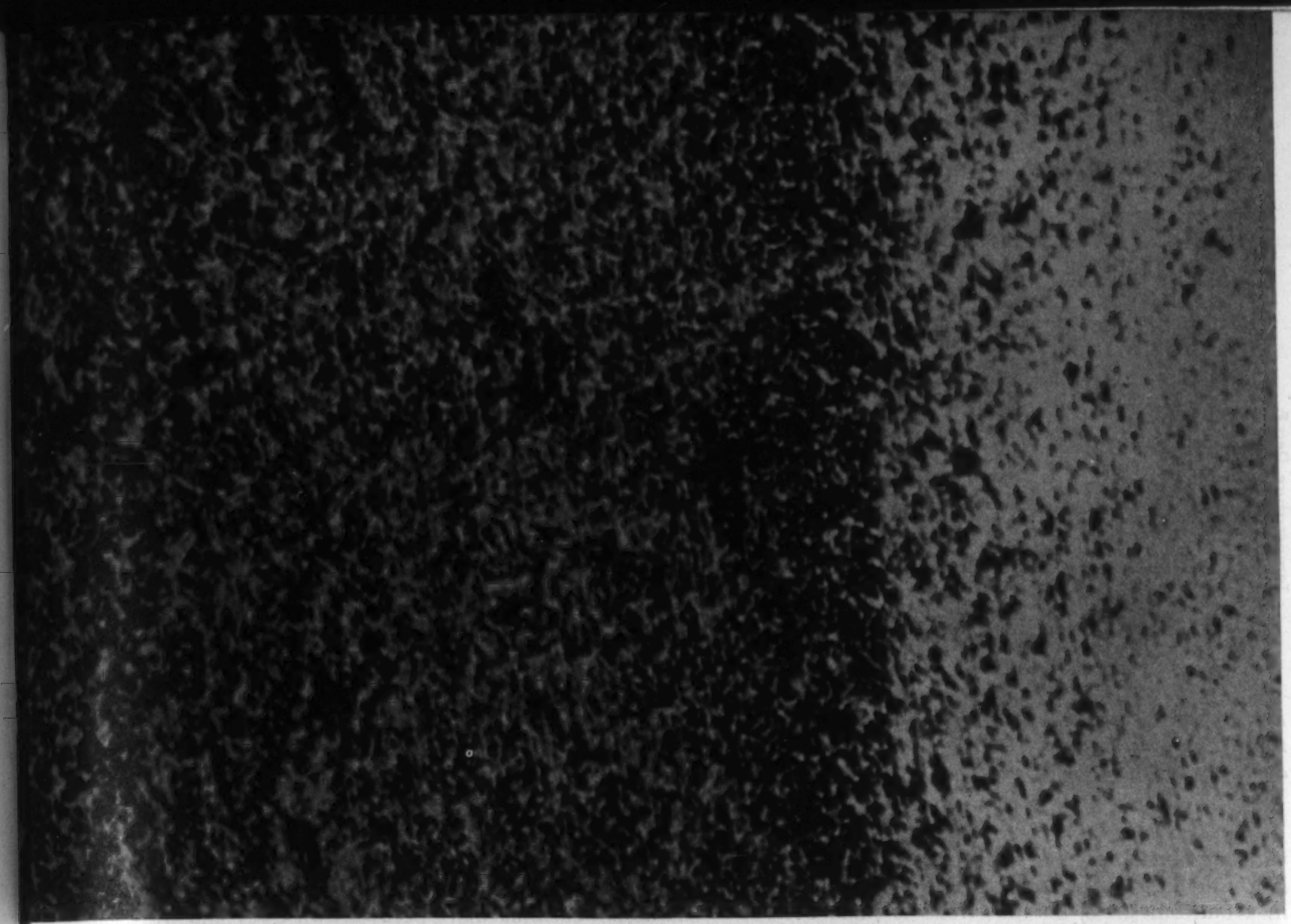


*Fig. 3. Microstructure (100X) of the hardened section of the same bearing, after hardening to 0.009 in. depth in 7/10 of a second. The lighter area is the hardened case, and the nature and uniformity of the boundary area are clearly evident.*

independent of the geometry of the part and may be made as thin as 3 thousandths of an inch or as deep as 60 thousandths of an inch at will.

## Practical Advantages

Megacycle energy has a number of practical advantages in addition to its ability to confine its heat to the surface layer. Slow-speed low-frequency induction heating carried with it many engineering objections, among which should be noted:

(1) Oxidation and scaling.
(2) A tempering or weakening of an internal layer due to excess stored heat in a too thick surface layer.
(3) Distortion or warping.
(4) Undesired depth of surface heat treatment.
(5) Inability to handle either small parts or thin-walled parts.
(6) The necessary use of bulky heating coils requiring relatively close positioning to the work.

Megacycle heat has overcome these difficulties in the following manner:

(1) Oxidation or scaling is a chemical reaction which requires time. It has been found that, when the heat treatment is accomplished in one second or less, scaling is completely eliminated even in ordinary atmosphere.

(2) Tempering or weakening of the adjacent internal layer is a function of the temperature-time relationship which controls the degree of tempering. One of the illustrations shows that it is possible to have a fully hardened case without measurable tempering of the adjacent internal layers. Much of the trouble encountered with lower frequency methods is directly traceable to the long heating time which allows the heat to penetrate too deeply into the core. Correction of the evils of slow and too deep heating is the fundamental reason for megacycle heat and for heat treat periods of 1 second or less.

(3) Distortion is closely associated with uniform case thickness. The amount of distortion experienced

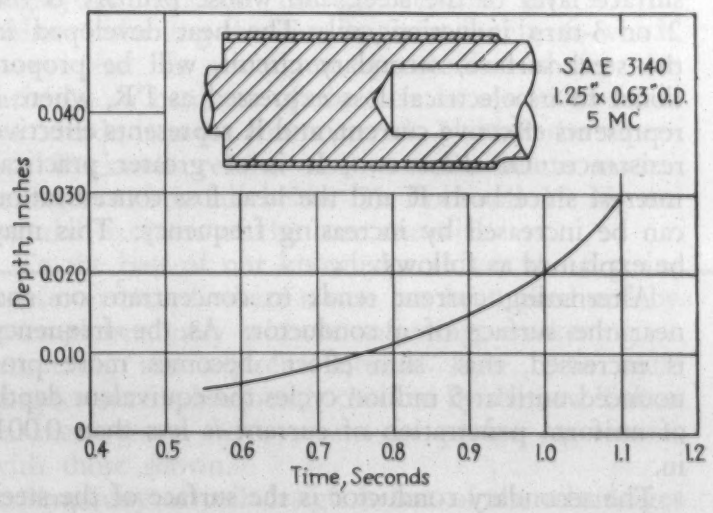



*Fig. 4. The effect of time of heating on case depth of the shaft previously illustrated, using 5-megacycle induction heating.*

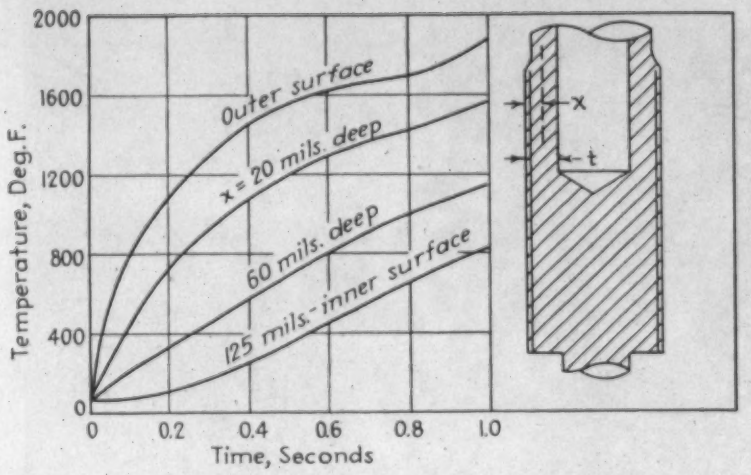



*Fig. 5. For the same shaft as in the preceding illustrations, this chart shows the temperature at particular depths below the bearing surface, as a function of time.*

with megacycle heat has in all cases been negligible. Not only does the uniform section of the case result in a uniform stress, but this stress is small because the hardened layer is thin. It is important to note that by preventing the spread of the surface heat into the core, the bulk of the part remains unchanged and capable of maintaining the original dimensions.

(4) In the case of small parts and of thin-walled parts, it is essential that a frequency in the order of 2 million to 15 million cycles per second be used.

(5) Smaller heating coils as well as less critical spacing between the coils and their work piece is another and highly practical consequence of megacycle heat.

## Operating Factors

The process of induction heat generation is that of a simple transformer, whose 1-turn secondary is the surface layer of the steel, and whose primary is the 2 or 3-turn induction coil. The heat developed in the steel surface, secondary circuit, will be proportional to its electrical loss expressed as $I^2R$, where I represents effective current, and R represents effective resistance. Of these two, R is of greater practical interest since both R and the heat loss concentration can be increased by increasing frequency. This may be explained as follows:

Alternating current tends to concentrate on and near the surface of a conductor. As the frequency is increased, this "skin effect" becomes more pronounced until at 5 million cycles the equivalent depth of uniform penetration of current is less than 0.001 in.

The secondary conductor is the surface of the steel part. Its resistance increases directly as the rising frequency forces the current to flow in a thinner and thinner sheet. The relationship is such that when the frequency is made 4 times as high, the resistance will have doubled. It therefore follows that for the same current in the same one-turn short-circuited secondary, twice as much heat energy will be developed and, what is more important, it will be concentrated into a thinner surface layer and thus produce a steeper temperature gradient.

The applied watts per square inch of surface must be considerably greater than the rate of heat loss by conduction from the surface to the core. Practical values which have given satisfactory results lie between 10 and 15 kw. per sq. in. of surface to be treated.

The cost of heat-treat energy depends upon the efficiency of the means for frequency conversion and not at all on the frequency as such. For example, 5 megacycle energy is fully as economical and in many cases considerably more so than lower frequency heat. In a particular application, 50 in. of surface was hardened 0.020 in. deep for each one cent's worth of energy. Cost depends upon how accurately the heating energy is controlled. Obviously the cost per square inch will increase directly as the depth of steel heated. For this reason, it is economically proper in most applications to restrict the depth of the hardened layer to slightly more than the allowable wear of the part. Had it been necessary to heat 0.2 in. deep to get the 0.02 in. case cited above, 90% of the power would have been thrown away and the cost increased almost 10 times.

The question of the best frequency is a common one. Recognizing motor generator, spark gap, and tube units, there are available 10 KC, 30 KC, 300 KC, 450 KC, 2 MC, 5 MC, 15 MC and 30 MC all for induction heating. There is no magic "best" frequency. There are, however, broad zones of good usage depending upon the results desired. Really *thin* case hardening has thus far required megacycle energy, and this may be best demonstrated by examining the accompanying illustrations.

## Characteristics of the Hardened Surfaces

An interesting case is that of the gun synchronizer shaft of which a half-section view appears in Fig. 1. The two bearing surfaces were surface hardened to a depth of 0.20 in. with a heating time of 1 second. (A depth of hardness of 0.009 in. is produced by a heating period of 0.7 sec.) The shaft is automatically tripped into a water quench at the end of this heating period. A job like this is particularly difficult

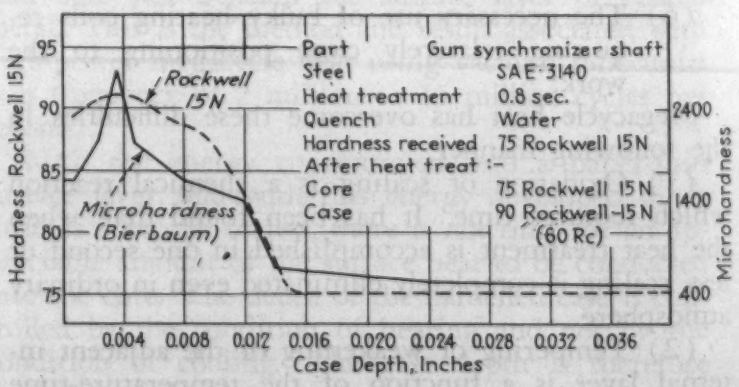



*Fig. 6. Hardness gradient from surface to unhardened region of the gun synchronizer shaft, as measured both by superficial Rockwell and Bierbaum microhardness tester. No measurable softening of the underlying metal is evident.*

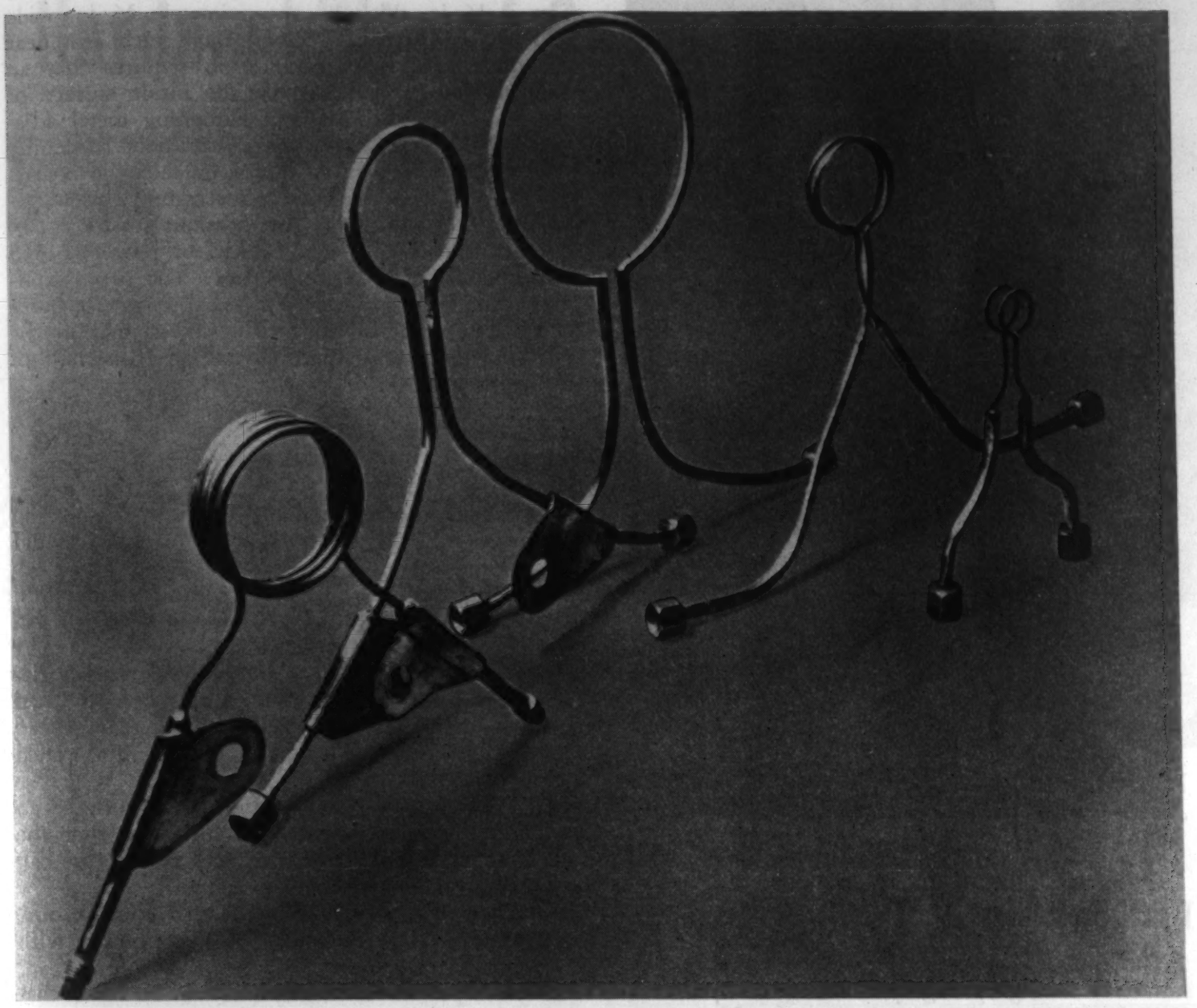


*Fig. 7. A group of induction heating coils in use on particular jobs requiring megacycle frequencies.*

because of the thin wall over the hollow portion of the shaft. The shaft is ⅝ in. in diameter and the wall thickness in the hollow portion is only ⅛ in.

The hardness record for this surface hardened shaft, shown in Fig. 1, reveals that on the upper bearing the hardened layer tapers away to zero thickness as it approaches the spline. This was a necessary compromise as the specifications did not permit any extra hardness on the spline teeth. Fig. 2 shows the hardened area of the lower bearing. Fig. 3 shows the microstructure of the sectioned case-core boundary for a somewhat thinner case.

Fig. 4 shows the relation between case depth and time of treatment, using 5-megacycle heating, on the shaft in question. It will be noted that the relation is roughly linear up to about 1 second for the power used. When the time is increased much beyond 1 second, the slope of the curve increases so rapidly that accurate control of case depth becomes difficult.

Fig. 5 demonstrates how the surface temperature increases during the heating period. The internal temperatures rise very rapidly, and if tempering of the underlying material is to be prevented, the time must be limited during which the core metal is exposed to the high temperatures.

The use of lower-frequency methods of surface hardening invariably introduces some softening or tempering of the underlying material because of the longer times involved. A striking illustration of how megacycle induction heating hardens the surface without softening the core is given in Fig. 6, which shows (for the same gun synchronizer shaft) the variation in hardness of the case as measured from the outside into the core material. Neither the superficial-Rockwell results nor the Bierbaum microhardness curves fall below 75 Rockwell 15 N, the orginial hardness of the core material.

To the best of our knowledge this is the first instance on record where a case has been produced by external heat only without softening, weakening or tempering the adjacent internal layer. The same samples were subsequently checked by the new Tukon hardness tester, with results in perfect agreement with those shown.

Simplicity of coil design is one of the advantages of this type of heating. As seen in Fig. 7, 1- 2- and 3-turn coils are the rule. The smallest coil illustrated transfers 15 kw. of energy and the 3-turn coil 40 kw. The single-turn coils were used on applications requiring between 20 and 40 kw.

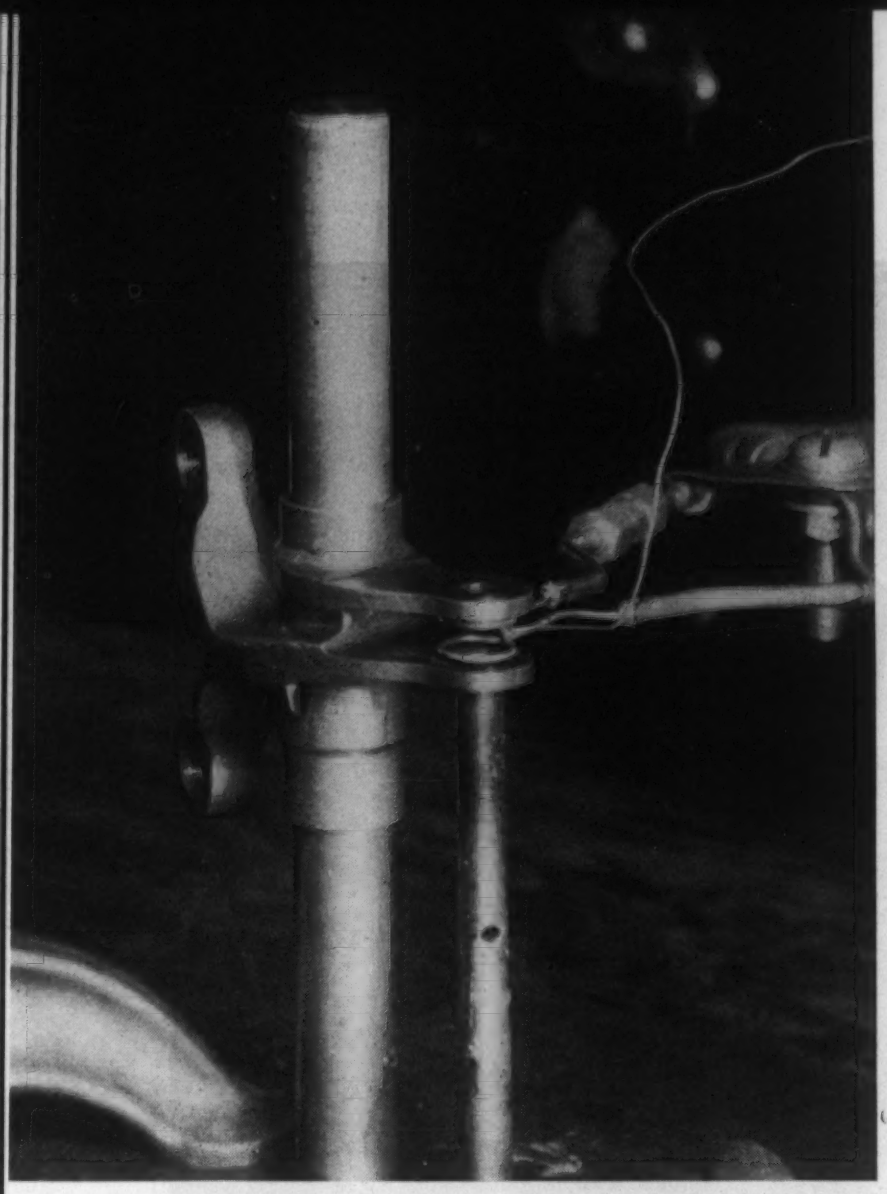


*Fig. 8. Induction heating arrangement for hardening annular rings on the inside faces of both arms of the clevis of an Allison engine rocker arm.*

## Typical Applications

The applications already established for ultra-thin surface hardening by megacycle heating are well diversified. An interesting case is that of a Navy sextant gear approximately 3 in. o.d. by 0.020 in. thick, made of S.A.E. 1090 steel. The surface is heated to 1600 F. with 12 kw. of energy in ⅔ of 1 second and self-quenched, *i.e.* no external coolant is used. The teeth are hardened to a depth of 0.020 in. to a hardness of 63 Rockwell C. Core hardness was 20 Rockwell C.

Another part is a Grumman wing hinge bolt approximately 10 in. long by 1½ in. o.d. This part is heated with 40 kw. of power at a frequency of 3 megacycles and is self-quenched. The part is scanned, *i.e.* pulled through the heating coil at the rate of 5 ft. per min. A case hardness of 50 Rockwell C is developed to a depth of 0.025 in.

Ideally representative of megacycle heating's special suitability is its application on an ordinary spur gear approximately 2½ in. o.d. by ¼ in. thick made of S.A.E. 1045. The gear is hardened with only 15 kw. of energy applied with a single turn coil in 1¼ sec. The part is self-quenched at ordinary room temperature. Even with the small tooth, the hardened portion is safely restricted to the tooth itself and does not penetrate appreciably into the root.

Still another part is an Allison engine rocker arm which must have an annular ring hardened on the inside face of both arms of the clevis. The clevis arm is ⅛ in. thick by approximately ¾ in. wide and has a ¼ in. axle hole through each arm near the outer end. The specification requires that an annular ring be hardened on the inside surface of the two clevis arms without hardening metal adjacent to the ¼ in. axle hole and without hardening through to the outside of the ⅛ in. thick clevis arm.

This job is accomplished successfully by megacycle heating within the specifications set for it. In doing this particular job, 15 kw. of power at 3½ megacycles is applied for 1½ sec. The part is self-quenched. Fig. 8 shows the physical set up for hardening these annular rings. The coil shown in the picture will be recognized as one in the group of five previously shown.

## Conclusion

In considering the possible means for achieving thin case hardening, the following four points should be remembered:

1. That *thin* case hardening requires limitation of the heating time to approximately one second.
2. That for a given power megacycle energy develops surface heat faster and cheaper than low-frequency energy does, and that it can readily do so even on small and thin walled parts.
3. That distortion and scaling of the surface can be virtually eliminated. At the same time the results of prior heat treatment of the core can be preserved.
4. That extremely simple one-turn coils become the practical inductors of high power with megacycle energy.

With respect to distortion it should be noted that the gun synchronizer shaft previously discussed, with a hardened case 0.020 in., was one of a large group all of which were finish-ground to final dimensions before surface hardening with megacycle energy. The maximum measureable dimension change was in all cases less than 0.0001 in. To the best of our knowledge, this is the first time that finish grinding prior to induction surface hardening has proven practical and satisfactory.

Vacuum tube induction heating units are simple devices, utilizing conventional transformers, switch gear and a power tube. The fixtures for applying the heat to the work are made up of ordinary copper tubing and are easily handled.

With this new and highly effective form of electrical heat many old processes of manufacture have been reduced from hours to seconds and many new processes have come into the realm of practicability for the first time. In addition to the surface hardening of steel, there is brazing, soldering, the sterilization and dehydration of food, the heating of plastics, the setting of cements, and many many other important uses.

Electronic heat is destined to be a vital factor to the extension of old industries and to the creation of new industries during the coming post-war era.

# Hardenability of Cast Steel – A SYMPOSIUM

*In the heat treatment of these hull steel castings for tanks, hardenability is an important consideration.*

## Introduction

**By C. W. BRIGGS**

*Technical and Research Director, Steel Founders' Society of America, Cleveland*

NUMEROUS ARTICLES have appeared in the technical press of the country on the subject of hardenability and the use of the end-quench test for wrought steels. Hardenability data are available for practically every type of wrought steel produced. However, the following articles are the first to appear in the technical press regarding end-quench studies on cast steels. This does not mean that these studies are the first investigations made on this subject in the steel casting industry. All the manufacturers of armor castings have been studying the hardenability of their steels during the past few years. Such information as they obtain is on the restricted list.

The publication of this series by Caine, Wellauer and Kiper is made to advise the engineer and purchaser of steel parts that the steel casting industry is actively engaged in hardenability considerations, and that sufficient information is available so that broad conclusions can be drawn. It will be evident from a review of the following articles that:

1. Cast steel and wrought steel of the *same* composition have similar hardenabilities as illustrated by the end-quench test.
2. Commercial cast steel will in general show slightly higher values than commercial wrought steel of the same carbon content, due to the higher silicon, aluminum, and sometimes manganese, contents of cast steel, since all cast steels are dead-killed steels.
3. Hardenability of cast steel is dependent upon composition and grain size in exactly the same manner as wrought steel.
4. Information available on wrought steels can be used for cast steels of similar content, by the application of a multiplying factor.
5. End-quench tests on cast steel can be used for calculating the hardness gradients of cast steel sections in the quenched and tempered conditions.
6. The substitution of one cast steel for another to obtain similar hardenability is possible with cast steels as with wrought steels.
7. An understanding of the properties developed in castings of varying sections can be obtained by the use of the end-quench test as a routine control in steel foundry operations.

# Hardenability of Cast Steel and Wrought

by J. B. CAINE

*Metallurgist,*
*Sawbrook Steel Castings Co.,*
*Lockland, Ohio*

HEAT-TREATED STEEL CASTINGS are here to stay, notwithstanding those few die-hards who still contend that a complicated casting cannot be quenched. After the war, when the full story of the heat treatment of massive complex castings to the most rigid ballistic specifications may be told, even those die-hards will be convinced. In fact, it may become necessary at that time to go to the other extreme and preach that every designer's nightmare cannot be cast and dunked in water any old way and still be kept in one piece.

The basis and control of heat treatment are hardenability. With the increasing use of heat-treated steel castings, the hardenability of cast steel becomes correspondingly of greater importance. Even though all other physical properties of cast steel have been found comparable with those of wrought steel, the significance of the hardenability test warrants a checking.

The hardenability ranges of a number of types of fine grained cast steel (A.S.T.M. grain size 6 to 8) have been checked with the results shown in Figs. 1 to 4. The average hardenabilities of comparable wrought steels are also given, as a determination of a relation between the hardenability of cast and wrought steel makes available to the users and producers of cast steel all the wealth of information on wrought steel that has recently been published.

There is a significant difference between the average hardenability of cast steel and that of wrought steel. As shown by the hardenability curves, all the cast steels tested, with the exception of 1330, have a higher average hardenability than do wrought steels of the same specified composition. The reason for this is no mysterious quality obtained by casting, but is simply due to the slightly higher silicon and metallic aluminum present in these fine grained cast steels. The one exception (1330) is also a result of analysis. Cast medium manganese steel corresponding to S.A.E. 1330 steel is usually lower in manganese (1.30 to 1.60%) than wrought S.A.E. 1330 steel with 1.60 to 1.90% Mn specified.

## Dependence on Analysis and Grain Size

The fact that the hardenability of cast steel is dependent upon composition and grain size in exactly the same manner as wrought steel is shown in Fig. 5. The theoretical hardenability calculated from the analysis and grain size, using the data of Grossman and Field, checks almost exactly with the hardenability determined experimentally. The only significant difference is for the 4130 analysis, a difference that is probably tied up with carbide solution.

Rowland[1] checks this point. He shows that cast and rolled specimens from the same heat have, within the limits of experimental error, exactly the same hardenability as measured by the end-quench test. Rowland's conclusions are certain to be misinterpreted before long. Just because the same heat has the same hardenability, whether cast or rolled, does not mean that steel castings have the same hardenability as wrought steels of the same specified chemistry. Analysis again.

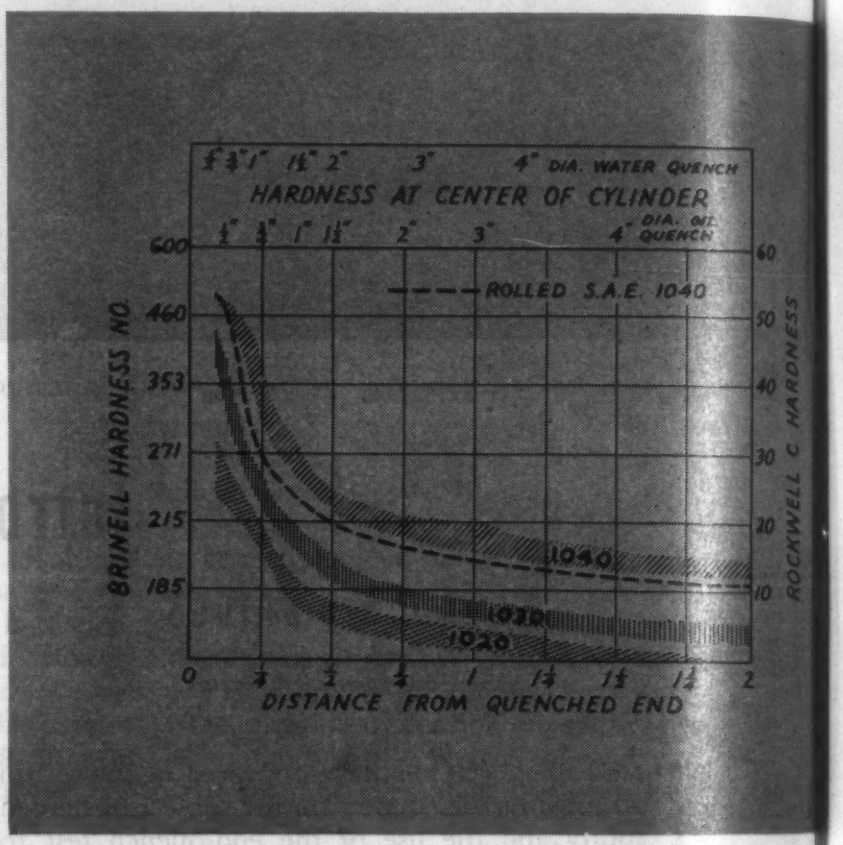



*Fig. 1. Hardenability of carbon cast steels.*

Silicon and metallic aluminum are usually not specified, nor is much attention paid to them in routine inspection. These elements do affect hardenability, metallic aluminum being one of the most potent hardening agents. Fine grained cast steel usually carries higher silicon and aluminum than does fine grained wrought steel, therefore the hardenability of these cast steels is slightly higher than wrought steels of the same nominal chemistry.

The hardenability results as revealed in the first four charts are shown as ranges, not averages. Single lines are all right for experimental heats, but this test is a production tool and in production low and high limits, and spread, are all important. The ranges

shown are, of course, established by the analysis of the heats tested; but as the specimens represent production heats cast over a period of years, they are fairly representative. The greater spread for a given specified analysis shown by the alloy specimens stands out like a black eye. With the need of increasingly closer control of chemical composition, the higher hardenability is self-evident. From the practical standpoint, however, there are several other angles to be considered.

## Control of Residuals

One of the most important factors involves the consumer, even though the factor is one of control of residuals. The small, fast melting units used in the production of small and medium size steel castings do not allow the laboratory sufficient time to determine residual alloys present in the scrap after the heat is melted, and the laboratory is the only place where they can be determined accurately. Even though a spectrograph were used and the residual determined after melt down, it usually is not possible to switch the heat to another analysis, as can be done in the rolling mill.

The most fool-proof way to control these residual alloys, in cast as well as in wrought steel, is to specify an alloy containing these residual elements—alloy steels containing not one alloy (a very inefficient method of obtaining hardenability in any case), but several alloys. In wrought steels there may be only a cost advantage in these alloys, in normal times. In steel castings this is advantageous not only from the cost standpoint, but also from strictly a quality standpoint.

Another important factor is consultation with your foundryman about alloys. He knows what his residuals are; you do not. This little point may save one of those embarrassing moments when a well behaved steel suddenly turns temperamental. A little residual nickel or molybdenum can very well be the cause. If your steel foundryman makes a lot of nickel or molybdenum steels, don't expect him to be superman and keep all traces of nickel and "moly" out of your pet analysis. He should; but with human nature as it is, someone is going to slip occasionally.

## Role of Aluminum

Another difference between cast and wrought steel, not generally recognized by the consumer, is the role of aluminum in cast steel. Aluminum is the prime variable controlling grain size, an extremely important factor in hardenability, and its role should not be overlooked. In wrought steel, and especially in fully killed wrought steel, aluminum is used almost exclusively for grain size control. Aluminum is used in the steel foundry not only to control grain size, but also as a deoxidizer. Steel, to be used for castings, must freeze without evolving the slightest trace of gas, and must also be capable of absorbing oxides and gas from the mold. The deoxidation procedure must, then, be carried much further than that required for wrought steel; furthermore, the deoxidation procedure must depend upon the type of molds used for receiving the steel.

Larger castings—at least those made in the past before grain-size control was appreciated—were made in dried molds. These castings were usually poured with silicon-killed steel and were coarse grained. Small castings are usually poured in undried molds and require hot steel capable of absorbing oxygen from the water in the sand. The amount of aluminum required to produce this highly deoxidized steel invariably makes this steel very fine grained.

Unless the grain size of cast steel is specified, it can generally be said that open-hearth steel, used to pour large castings, is coarse grained; and electric furnace steel used to pour small castings is usually fine grained. There are plenty of exceptions to this general statement. Open-hearth steel can easily be made fine grained, and much of it is being made to

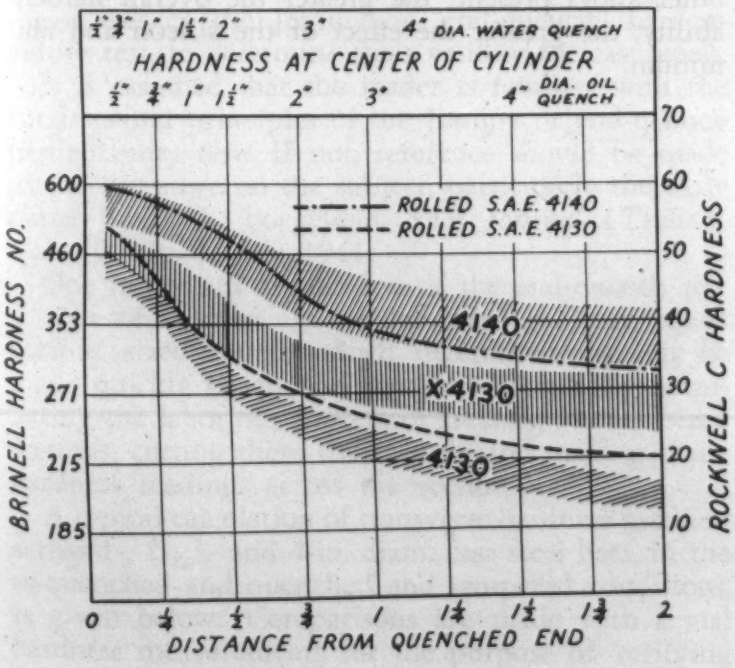



*Fig. 2. Hardenability of chromium-molybdenum cast steels.*

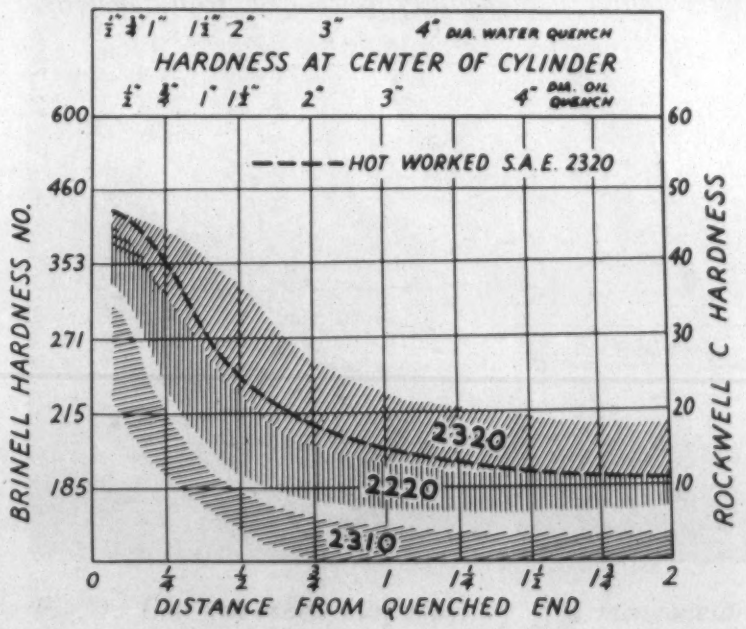



*Fig. 3. Hardenability of nickel carburizing cast steels.*

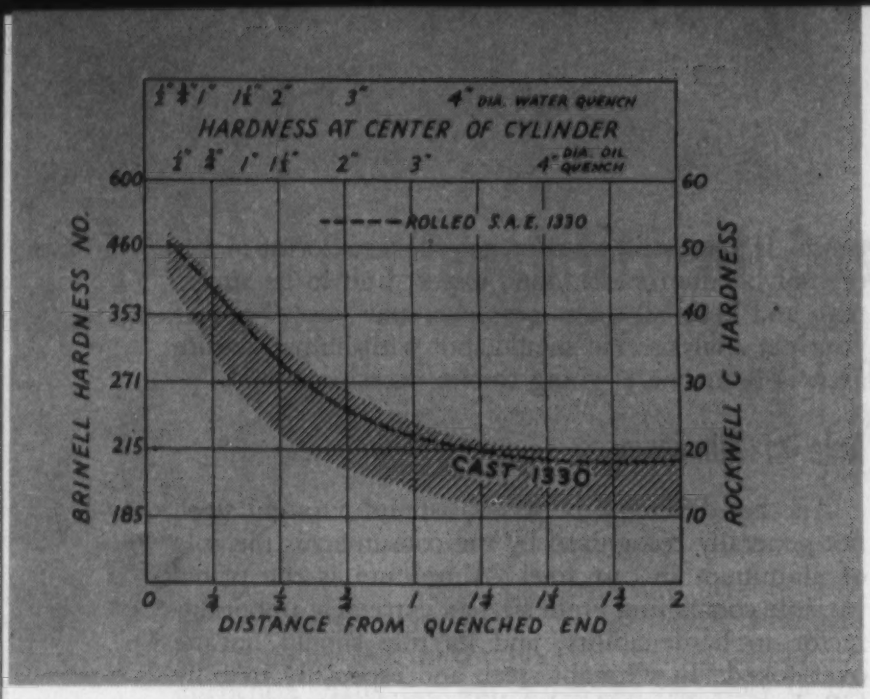



*Fig. 4. Hardenability of medium manganese cast steels.*

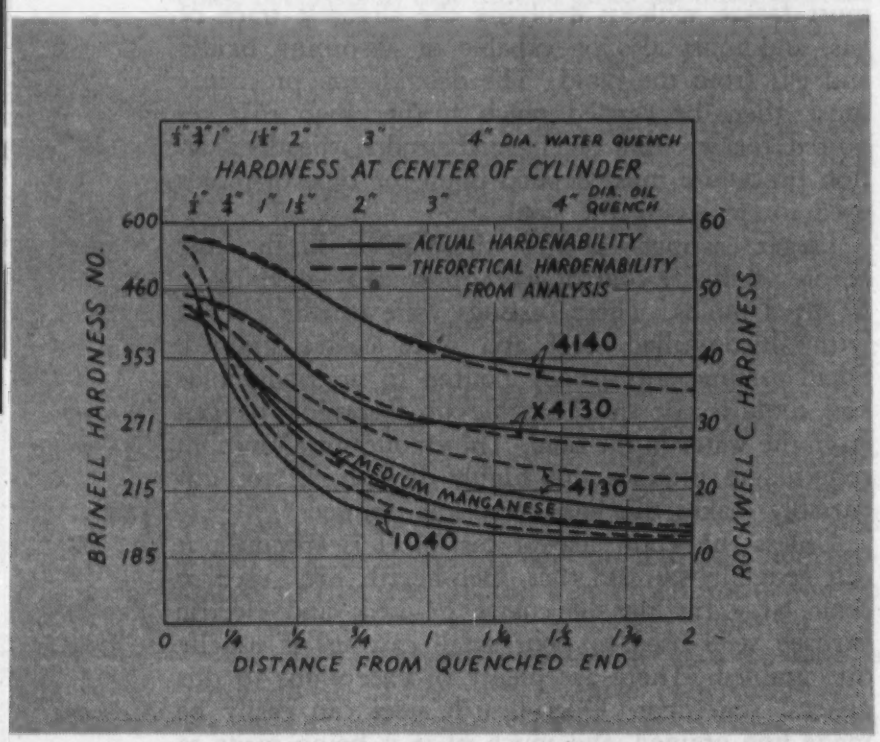



*Fig. 5. Comparison of actual hardenability with theoretical hardenability calculated from analysis.*

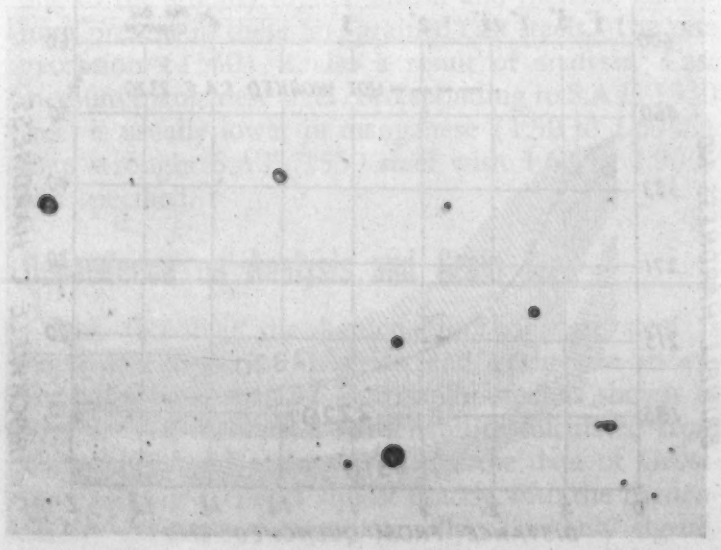


*Fig. 6. Silicate inclusions present in coarse grained cast steel. 250X.*

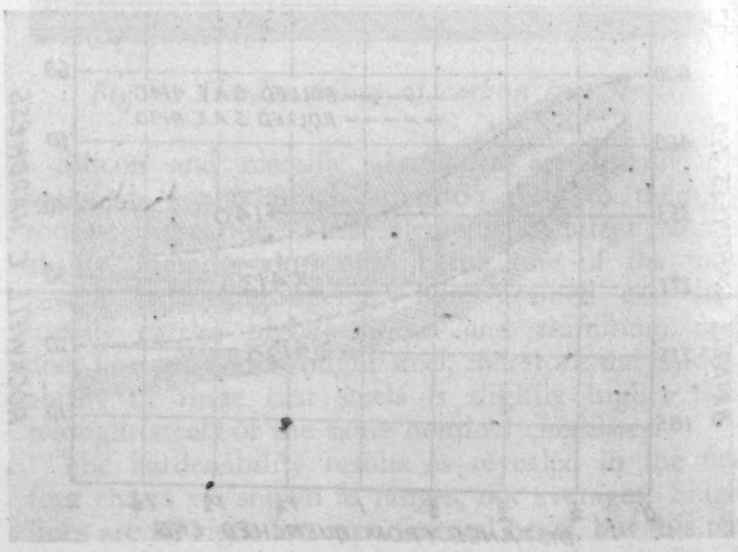


*Fig. 7. Alumina inclusions present in fine grained cast steel. 250X.*

grain-size specifications today. Electric furnace steel for small castings is almost invariably very fine grained. Electric steel for castings can be made coarse grained; but the increase in time required to deoxidize the steel completely in the furnace, so that no aluminum is needed to eliminate the last trace of oxide, is usually not warranted except for high temperature service.

## Determining the Grain Size

The inherent grain size of a steel casting is a little easier to determine than that of wrought steel. Of course the easiest way is to consult the foundry that made the casting. Occasionally an orphan casting that is to be heat treated is encountered. A standard grain size determination may require too much time. The desired information can be obtained by a metallographic examination of the oxide inclusions. Fortunately, the inclusions in cast steel are not distorted by plastic deformation and are easy to study. A coarse grained silicon-killed steel will invariably show silicate inclusions, as shown in Fig. 6. A fine grained aluminum-killed steel will show no silicate inclusions, but will show alumina inclusions, as indicated in Fig. 7.

This determination does not require a test piece. The type of inclusions can be determined by using a fairly coarse turning. The inclusions in this case are distorted by cold work but, with a little practice, they can be distinguished.

In conclusion, it can be said that there is no difference in the hardenability of a steel, just because it is cast. The only difference between a cast and a wrought steel is caused by a slight modification in analysis. The combined multiplying factor resulting from the higher silicon and metallic aluminum in fine grained cast steel, as compared with fine grained wrought steel, is about 1.20. This is partially offset by the slightly smaller grain size of cast steel. The increase in overall hardenability depends upon the type and amount of other alloys present; the greater the overall hardenability, the greater the effect of the silicon and aluminum.

In practice, this slight difference in hardenability can be compensated, if one is used to the hardenability of wrought steel, by lowering the carbon content of the cast steel not more than 0.05%. This point has been checked from both the theoretical and the practical standpoints for S.A.E. 4140 steel. A 4140 cast steel is indistinguishable from a S.A.E. 4145 wrought steel. As the overall hardenability decreases, the decrease in carbon content can be less. The difference in hardenability due to chemistry in carbon steels—at least up to 0.60% C—is not appreciable.

*Reference*

[1] *Metal Progress*, December 1943, page 1133.

# Use of the End-Quench Test for Cast Steel

by E. J. WELLAUER

*Supervisor of Research and Metallurgy*
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IN THE PRECEDING ARTICLE Mr. J. B. Caine excellently presented some of the fundamental phenomena associated with the "Hardenability" of cast steel. It was indicated that for a given SAE range cast steel will usually have a higher hardness than wrought steel, primarily because of the higher average manganese and silicon contents.

Several years of research at The Falk Corp. have verified the conclusion that the hardenability of cast and wrought steels of the same chemical composition, grain size and thermal history are identical. Tests were made by forging down cast steel rounds with a forged reduction ratio of over 15 times and no marked difference in hardenability was noted between Jominy bars machined from the casting and from the forged-down section. Since there is no difference between wrought and cast steel, it is logical to explore some of the usages of the Jominy or "end-quench" hardenability test, to determine their validity for cast steels.

It is assumed that the reader is familiar with the fundamental principles of the Jominy or end-quench hardenability test. If not, reference should be made to the literature on the subject, particularly the early paper by A. L. Boegehold, SAE *Journal* (*Trans.*), Vol. 49, No. 1, July 1941.

One important application of the end-quench test is that of calculating the hardness gradient across various sized rounds. Such determinations can be made quickly by an end-quench test, entirely eliminating the laborious process of treating various sized sections, cutting them transversely and making many hardness readings across the section.

A typical calculation of transverse hardness gradient across 1-, 2-, 3- and 4-in. diam. cast steel bars, in the as-quenched and quenched and tempered conditions, is given below. Comparisons are made with actual hardness measurements for the purpose of verifying the accuracy.

The steel used was an acid open-hearth manganese-molybdenum alloy cast steel with the chemical composition as tabulated in Table I.

*Table I.—Chemical Analysis of Test Heat*

| | |
|---|---|
| Carbon | 0.35 % |
| Manganese | 1.08 % |
| Sulphur | 0.024% |
| Phosphorus | 0.033% |
| Silicon | 0.349% |
| Molybdenum | 0.165% |

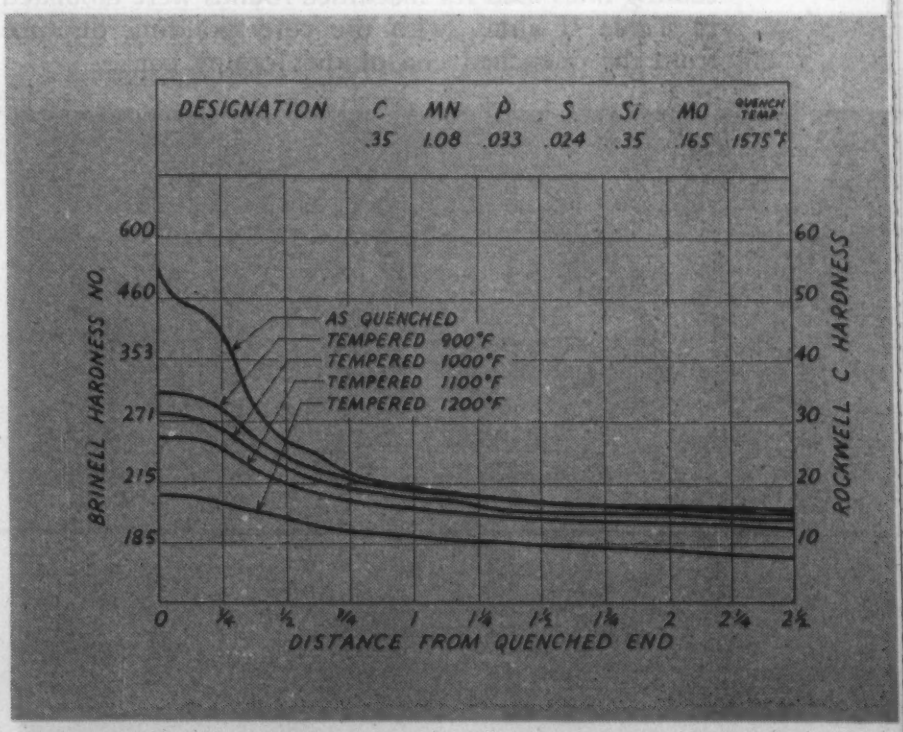



*Fig. 1. End-quenched hardenability of a manganese-molybdenum cast steel.*

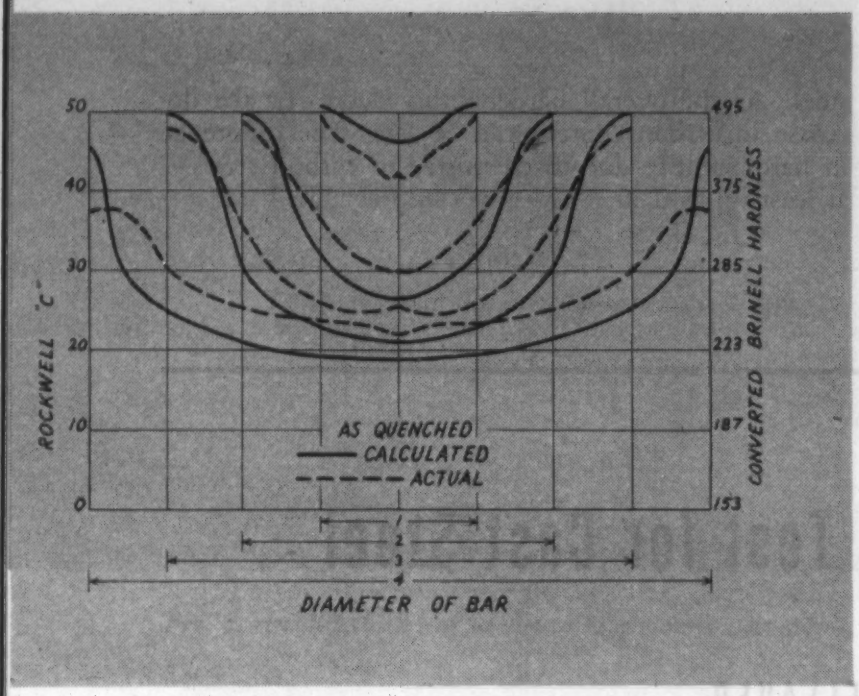



*Fig. 2. Comparison of actual and calculated hardness gradients on various section sizes of quenched manganese-molybdenum cast steel.*

Bars for verifying the results were cast with finish to machine to 1-, 2-, 3- and 4-in. diam. These bars were water quenched from 1575 F. and tempered.

Several end-quench bars were treated and the hardnesses read after quenching, and after quenching and tempering at 900, 1000, 1100 and 1200 F. The results are plotted in Fig. 1.

## Calculating the As-Quenched Hardness Gradient

The cooling rate at various locations across the diameter of a steel round has been determined by various investigators. At the Falk laboratories, the cooling rates used for machined rounds were tabulated in Table II along with the corresponding distance from the quenched end of the Jominy bar.

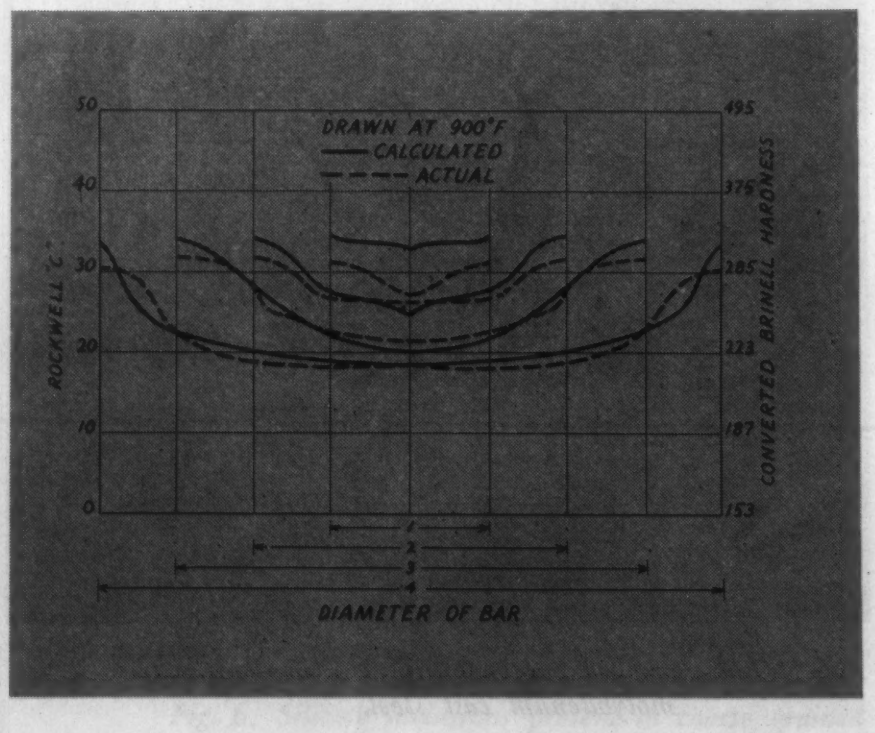



*Table II.—Cooling Rates and End-Quench Distance for Machined Rounds*

| | 1-in. Round | | 2-in. Round | | 3-in. Round | | 4-in. Round | |
|---|---|---|---|---|---|---|---|---|
| | Water q'nch | Oil q'nch | Water q'nch | Oil q'nch | Water q'nch | Oil q'nch | Water q'nch | Oil q'nch |
| *Surface* | | | | | | | | |
| Cooling rate* | 850 F. | 120 F. | 550 F. | 58 F. | 400 F. | 30 F. | 140 F. | 15 F. |
| Distance from quenched end** | 0.5 | 2.5 | 1.0 | 5.0 | 1.25 | 8.0 | 2.5 | 12.5 |
| *¾ of Radius* | | | | | | | | |
| Cooling rate | 220 F. | 68 F. | 78 F. | 31 F. | 57 F. | 16 F. | 24 F. | 8 F. |
| Distance from quenched end | 1.5 | 4.0 | 4.0 | 8.0 | 5.0 | 12.0 | 9.5 | 18.0 |
| *½ of Radius* | | | | | | | | |
| Cooling rate | 135 F. | 53 F. | 46 F. | 24 F. | 27 F. | 12 F. | 14 F. | 6.5 F. |
| Distance from quenched end | 2.5 | 5.0 | 6.0 | 9.5 | 8.5 | 14.5 | 13.0 | 21.0 |
| *¼ of Radius* | | | | | | | | |
| Cooling rate | 115 F. | 48 F. | 36 F. | 19 F. | 18 F. | 10 F. | 10 F. | 5.5 F. |
| Distance from quenched end | 3.0 | 5.5 | 7.0 | 11.0 | 11.0 | 16.0 | 16.0 | 24.0 |
| *Center* | | | | | | | | |
| Cooling rate | 100 F. | 45 F. | 32 F. | 18 F. | 15 F. | 9 F. | 8 F. | 5.5 F. |
| Distance from quenched end | 3.0 | 6.0 | 8.0 | 11.0 | 12.5 | 17.0 | 18.0 | 24.0 |

* Cooling rate—Deg. F. per Sec. at 1300 F.
** Distance from quenched end in sixteenths of an inch.
Q'nch—Quench.

Using these data and the as-quenched Jominy test of Fig. 1, the calculated transverse hardness gradient can be determined. The procedure is illustrated for the 3-in. round. The cooling rate for the center of a 3-in. water quenched round from Table II is 15 F., which corresponds to 12.5 sixteenths of an inch from the quenched end of the Jominy bar.

Referring to Fig. 1, the as-quenched curve shows that a Rockwell "C" hardness of 21 should result in the center of a water quenched 3-in. round. This value is plotted as illustrated in Fig. 2.

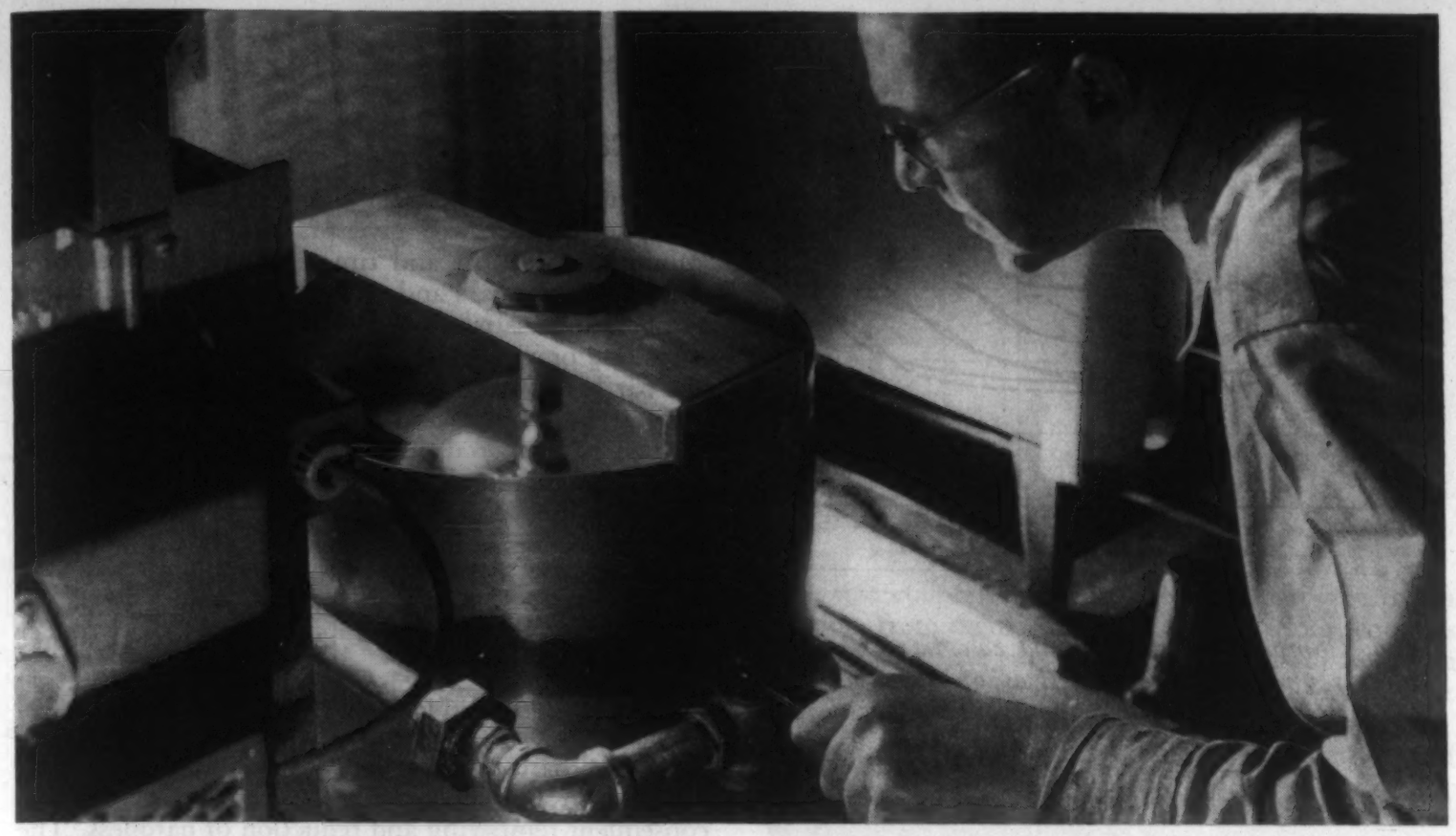
The cooling rate at ½ of the radius is found in Table II to be 27 F. per sec., which corresponds to 8.5 sixteenths of an inch from the quenched end or, from Fig. 1, the hardness at the ½ of the radius point should be 25 Rockwell "C."

The cooling rate at the surface is found in Table II to be 400 F. per sec., which corresponds to 1/16 in. from the quenched end or, from Fig. 1, should result in a hardness of 50 at the surface of the 3-in. round. These values are plotted as illustrated in Fig. 2.

Similarly, the hardnesses are secured for the ¼ and ¾ of the radii. For extreme accuracy, intermediate points should also be plotted, particularly if sharp changes are indicated in the slope of the cross-sectional hardness gradient. Cooling rates at various positions can be found in the SAE Handbook or other references.

Fig. 2 is completed by plotting the transverse hardness distribution for the other diameters. Also plotted are the measured cross-sectional hardnesses of the rounds which were actually quenched.

*Fig. 3. Comparison of actual and calculated hardness gradients on various section sizes of quenched and 900 F. tempered manganese-molybdenum cast steel.*



*Making a Jominy end-quench hardenability test. (Courtesy: Joseph T. Ryerson & Son, Inc.)*

## Calculated and Actual Results Compared

A study of Fig. 2 indicates that the results of the calculated and actual hardness at or near the surface compare very closely. In the center and intermediate points a difference of 5 Rockwell "C" points is noted. This error is about the average that is to be found when calculating the as-quenched hardness distribution across diameters up to 4 in. for both forged and cast steels, although in many instances differences of 2 Rockwell "C" points or less are obtained. The value of a probable accuracy of 5 Rockwell points might be questioned as being too wide for analytical purposes. There are four reasons why a check within 5 points is satisfactory; namely,

1. Many comparisons of calculated and actual hardness distributions across rounds up to 5 in. in diam. have indicated that the normal segregations of alloys or constituents across the diameter are sufficient to introduce hardness errors in excess of that normally expected by the computing process. A scientific computation is no more accurate than the probability of the attainment of uniform conditions in the actual piece.

2. Discrepancies in the end-quench bar either during quenching or grinding are likely to introduce variations of 1 or 2 Rockwell "C" points.

3. The cooling rates obtained in quenching the actual bars might not agree with the tabulated values. This factor must be carefully analyzed when hardness readings are obtained on those portions of the Jominy curve having a steep slope. For example, the Table II value for the oil quenched cooling rate of the center of a 1-in. round is given as 45 F. per sec. This is at a steep part of the end-quench plot, and a variation of 1 or 2 deg. in the actual cooling rate might easily result in a difference of 4 or 5 Rockwell "C" points.

4. The most important reason why the as-quenched curves are sufficiently accurate within 5 Rockwell "C" points is that 98% of structural members for machines, etc. are required to be tempered in order to provide sufficient ductility, machinability, and other properties. The larger problem, therefore, is: "Can the hardness distribution be calculated for quenched and tempered sections?" The tempered hardness can be obtained with extreme accuracy, as illustrated by the methods given below.

## Hardness Gradient after Tempering

The hardness readings along end-quench bars, end quenched in the usual manner and then tempered at 900, 1000, 1100 and 1200 F., are plotted in Fig. 2.

The method of plotting the tempered hardness gradient is again illustrated by the 3-in. round tempered at 900 F. The hardness on the tempered end-quench bars is read for the corresponding cooling rates shown in Table II. For the 3-in. section, the values to be plotted are as follows:

| | LOCATION | | | | |
|---|---|---|---|---|---|
| | Center | 1/4 Radius | 1/2 Radius | 3/4 Radius | Surface |
| Cooling rate.... | 15F. | 18F. | 27F. | 57F. | 400F. |
| Distance from quenched end in sixteenths of an inch..... | 12.5 | 11 | 8.5 | 5 | 1.25 |
| 900F. Tempered: Hardness Rockwell "C"..... | 20 | 21 | 23.25 | 30 | 34 |

These values are plotted in Fig. 3 along with similarly computed values for 1-, 2- and 4-in. diam. rounds. Except for the 1-in. section the results agree substantially within 2 Rockwell "C" points of the hardness obtained on the rounds actually quenched and tempered. The reason for the error in the 1-in. round is that the cooling rate on the specimen actually quenched, undoubtedly varied from the theoretical and, being on a sensitive portion of the end-quench curve, introduced greater error. However, the error for the 1-in. section is approximately 3 Rockwell "C" points.

Similar curves comparing the computed and actual hardness gradients of the 1-, 2-, 3- and 4-in. diam. rounds after tempering at 1000, 1100 and 1200 F. are plotted in Figs. 4, 5 and 6.

It is evident that for practical purposes a very close correlation of the computed and actual hardness gradients for quenched and tempered rounds can be secured.

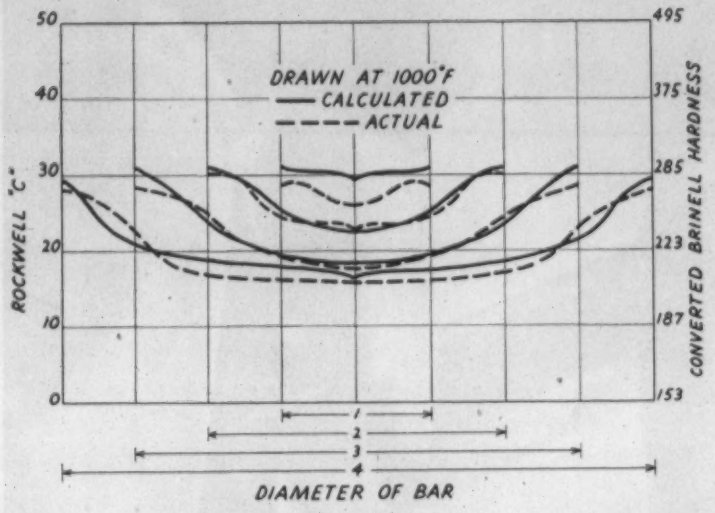



*Fig. 4. Comparison of actual and calculated hardness gradients on various section sizes of quenched and 1000 F. tempered manganese-molybdenum cast steel.*

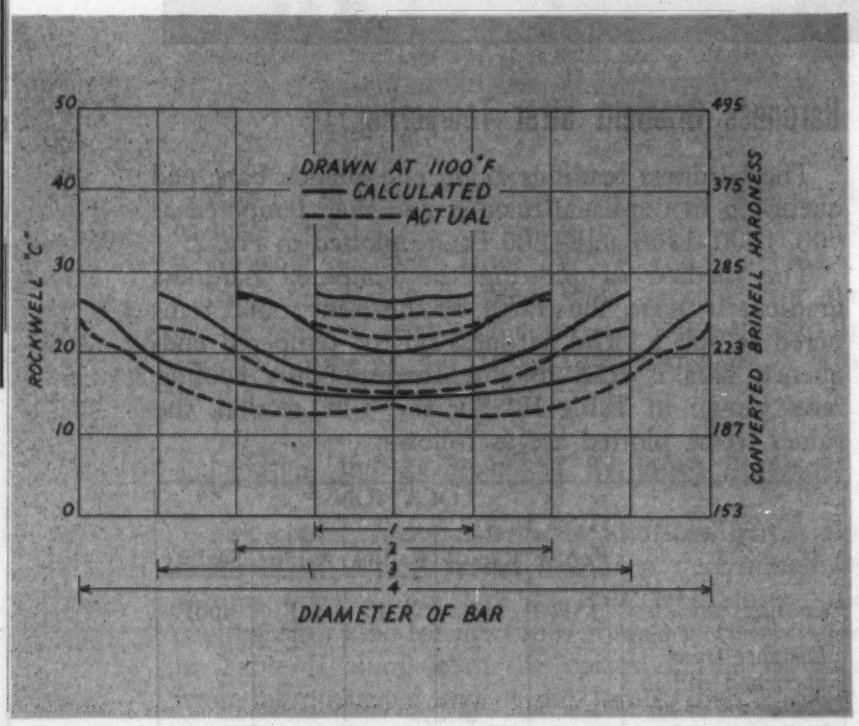



*Fig. 5. Comparison of actual and calculated hardness gradients on various section sizes of quenched and 1100 F. tempered manganese-molybdenum cast steel.*

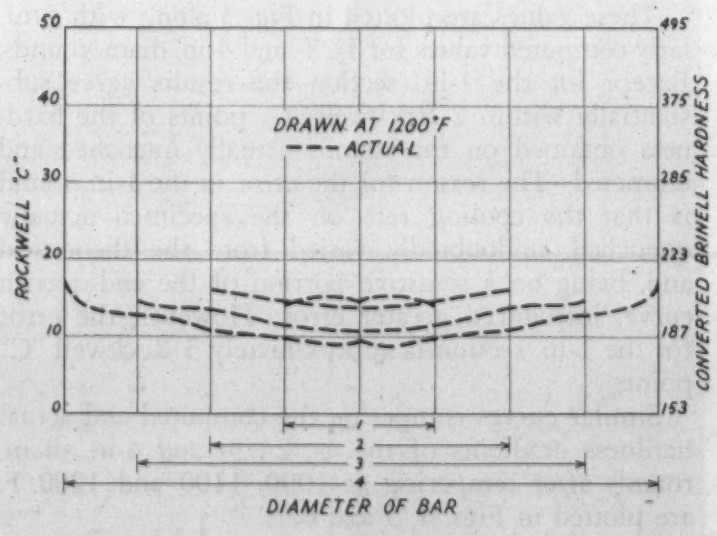



*Fig. 6. Experimental hardness gradients on various section sizes of quenched and 1200 F. tempered manganese-molybdenum cast steel.*

## Practical Notes

As in any other tests, attempts are made to provide short-cuts which will give practical answers with a minimum of effort and time. Instead of quenching 4 or 5 Jominy bars and tempering each at a different temperature, satisfactory results have been obtained with one or two bars. After quenching and reading, the bar is tempered at the lowest temperature desired, a new flat ground, and the hardness read. The bar is then re-tempered at the next higher temperature, a new flat reground, the hardness read, etc., until the entire periphery is ground with flats.

The use of this method for high alloy, low carbon steels must be examined critically because precipitation hardening phenomena can raise the hardness of a tempered section above that of the as-quenched condition.

The customary precautions must be given the preparation of Jominy bars which are to serve as a basis for hardness gradient calculations. The flats must be ground very carefully to avoid heat and a consequent tempering and reduction of hardness. The bars should be read on two sides and the results averaged. If the two sides do not agree within the limits of the desired accuracy, a retest should be made.

There is a tendency on the part of some metallurgists to treat the hardenability test as a precise mathematical solution. As previously stated, the accuracy is dependent only upon the limits imposed by the practical variations in the uniformity of the material, quenching process and test method which, every practical metallurgist knows, to his sometimes frantic despair, are wide.

## Summary

It has been the purpose of this paper to illustrate that the end-quench test can be used for calculating the hardness gradients of cast steel sections in both the quenched and the quenched and tempered conditions. The use of this type of calculation enables comparisons to be made of different heats and analyses of varying hardenabilities for definite applications, thereby entirely eliminating the costly and laborious method of actual quenching, tempering, cross-sectioning, and hardness reading.

Besides determining the suitability of a given heat for a particular purpose, the method allows studies to be made to determine the variations which can be expected between minimum and maximum ranges of hardenability and the effect of a predetermined tempering treatment.

Since the tensile strength is approximately equal to 500xBHN, these studies can give a close estimate of the resulting physicals of a given section and heat treatment.

It is very evident that cast steel follows the same laws pertinent to hardenability as govern the performance of wrought or welded steels.

# Hardenability of Some Cast Steels

by FRANK KIPER

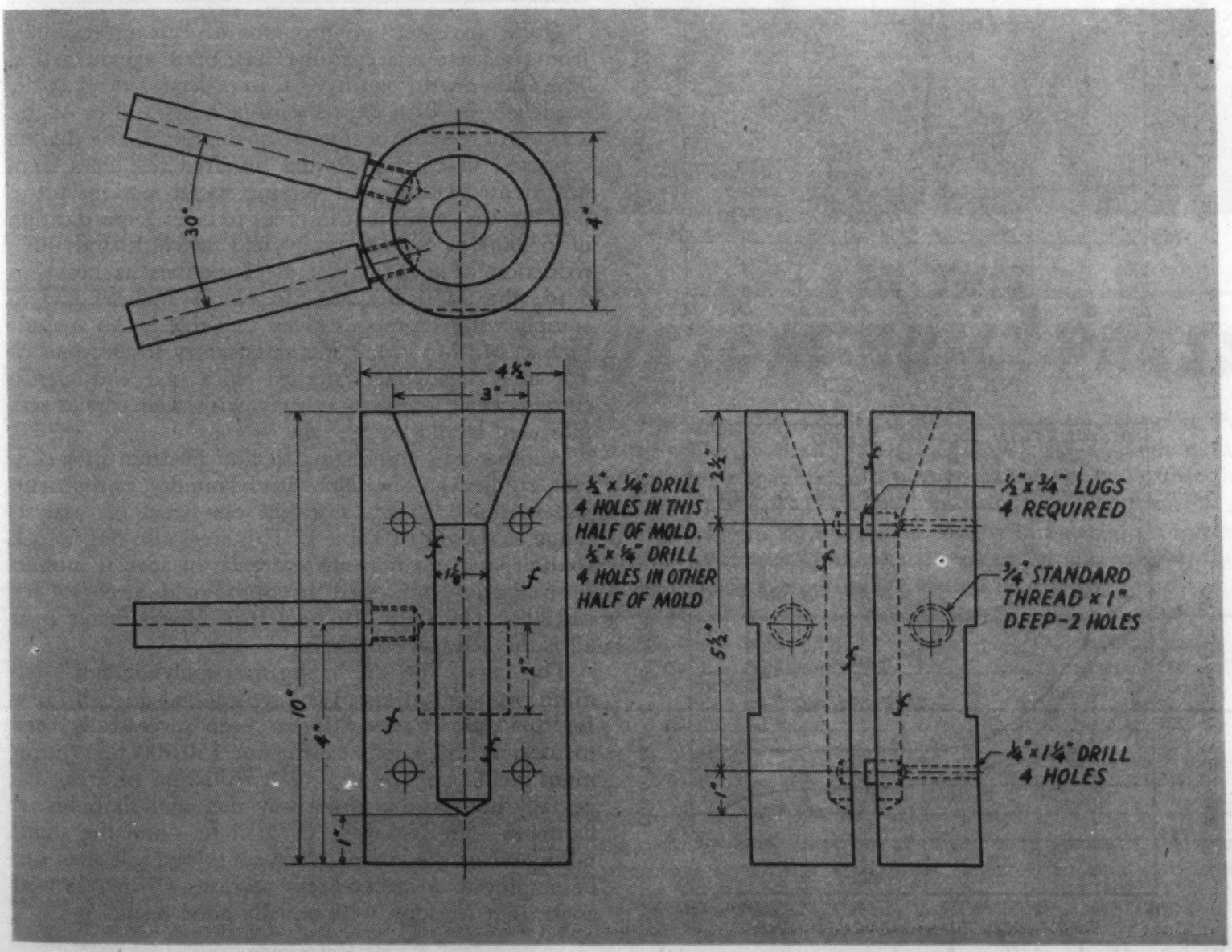
*Assistant to Plant Superintendent,*
*Springfield Plant,*
*The Ohio Steel Foundry Co.,*
*Lima, Ohio*

THE EMPIRICAL HARDENABILITY test, or the end-quench test, as described by Jominy and Boegehold[1], seems to be the tool for which the foundry metallurgists have been seeking for some time. The hardenability data of certain cast steels as made at The Ohio Steel Foundry Co. are presented with the thought in mind that hardenability properties of cast steel may be more widely known than they are at present.

The standard conditions for the test as set up by Jominy and Boegehold were followed very closely. The test coupons were for the most part selected at random from regular production heats. Some coupons were cast to size; these of course were compared with fully machined coupons from the same heat and were found to compare within experimental error.

The cast coupon was suggested by Walter Hildorf of the Timken Roller Bearing Co. (see Fig. 1). The coupons were normalized for 1 hr. at 1800 F. before machining, and were heated for quenching in an L & N hump furnace. The cupped ends, or ends to be quenched, were placed on a carbon block; this

*Fig. 1. Mold for pouring cast hardenability tests.*



successfully eliminated the problem of scaling on the end. All three grades of steel were of the fine grained type—No. 8 grain or smaller—and can be made in either the acid open-hearth or acid electric furnace.

In Fig. 2 is plotted the hardenability of a cast steel similar in analysis to the NE 9430 composition. Also included in Fig. 2 is the hardenability curve of a wrought NE 9430 steel as published by the American Iron and Steel Institute in "Contributions to the Metallurgy of Steel—No. 8." This shows that the cast 9430 steel has slightly better hardenability properties than the wrought steel. No doubt the difference in manufacturing methods and analysis variations contributed to this condition.

In Fig. 3 are shown two typical cast steels of the manganese-molybdenum composition. The Mn-Mo No. 1 of the chart (1.04% Mn, 0.40% Mo) has been used interchangeably with the cast NE 9430. It will be noted that the two curves are very similar, and

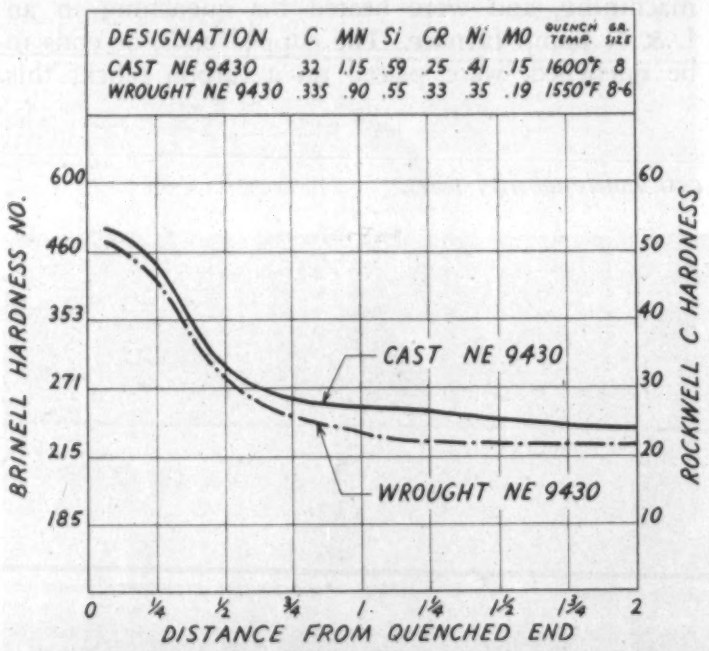



*Fig. 2. Hardenability of cast and wrought NE 9430 steels.*

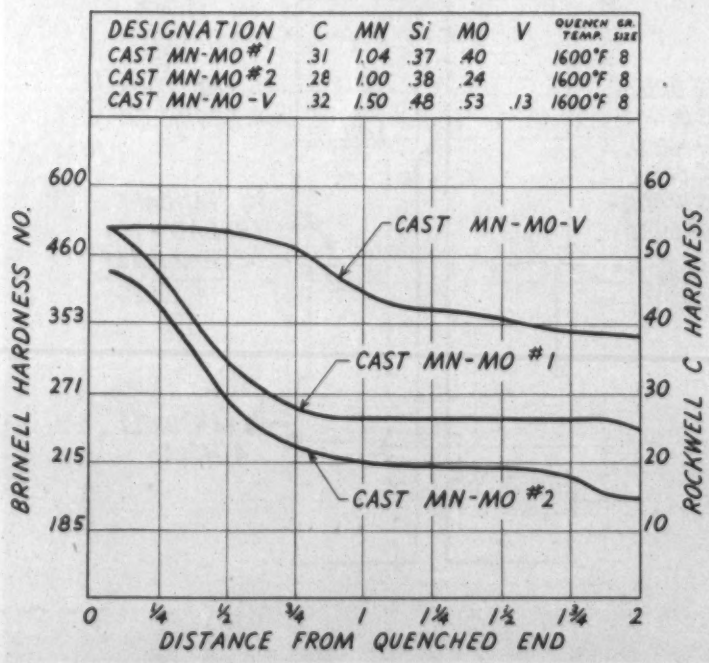



*Fig. 3. Hardenability of various manganese-molybdenum steels.*

that they have almost identical hardenability characteristics. These steels have met very successfully the Federal QQ-S-68lb specification (Steel Castings) for Class 4C1 (90,000 p.s.i. T.S.) in 5-in. sections or lighter, and Class 4C3 (120,000 p.s.i. T.S.) in 3-in. sections or lighter.

The manganese-molybdenum No. 2 composition (1.00% Mn, 0.24% Mo) of Fig. 3 illustrates the importance of alloy content with respect to hardenability. This curve was made from data taken from a cast steel of an analysis similar to the Mn-Mo No. 1 steel except for the molybdenum content, which was reduced from 0.40 to 0.24%. The full analysis is shown in Table I.

*Table I—Analyses of Cast Steels Studied for Hardenability Tests*

| Type | C | Mn | Si | Mo | Ni | Cr | V |
|---|---|---|---|---|---|---|---|
| NE 9430 | 0.28 to 0.32 | 0.90 to 1.10 | 0.25 to 0.50 | 0.12 to 0.15 | 0.30 to 0.40 | 0.25 to 0.35 | — |
| Mn-Mo No. 1 | 0.28 to 0.32 | 0.90 to 1.10 | 0.25 to 0.50 | 0.35 to 0.40 | — | — | — |
| Mn-Mo. No. 2 | 0.28 | 1.00 | 0.38 | 0.24 | — | — | — |
| Mn-Mo-V | 0.28 to 0.32 | 1.40 to 1.50 | 0.25 to 0.50 | 0.50 to 0.55 | — | — | 0.12 to 0.15 |

Quite an extensive program of cutting test bars from heat-treated castings has been conducted at The Ohio Steel Foundry Co., in order to correlate the hardenability data of the various heats and to obtain an idea of the practical value of the test. The program consisted in cutting several hundred test bars from heat-treated castings of varying metal sections up to 6 in. It was found that in order to meet a specification of 65,000 to 85,000 p.s.i. yield strength and 40% reduction of area in cast steel sections as heavy as 5 in., the 9430 and Mn-Mo No. 1 analyses had to comply with the ranges given in Table I. An analysis such as Mn-Mo No. 2 was satisfactory for sections of 1.5 in. These data, studied with the end-quench curves, were found to comply with what the curves indicated would be the case.

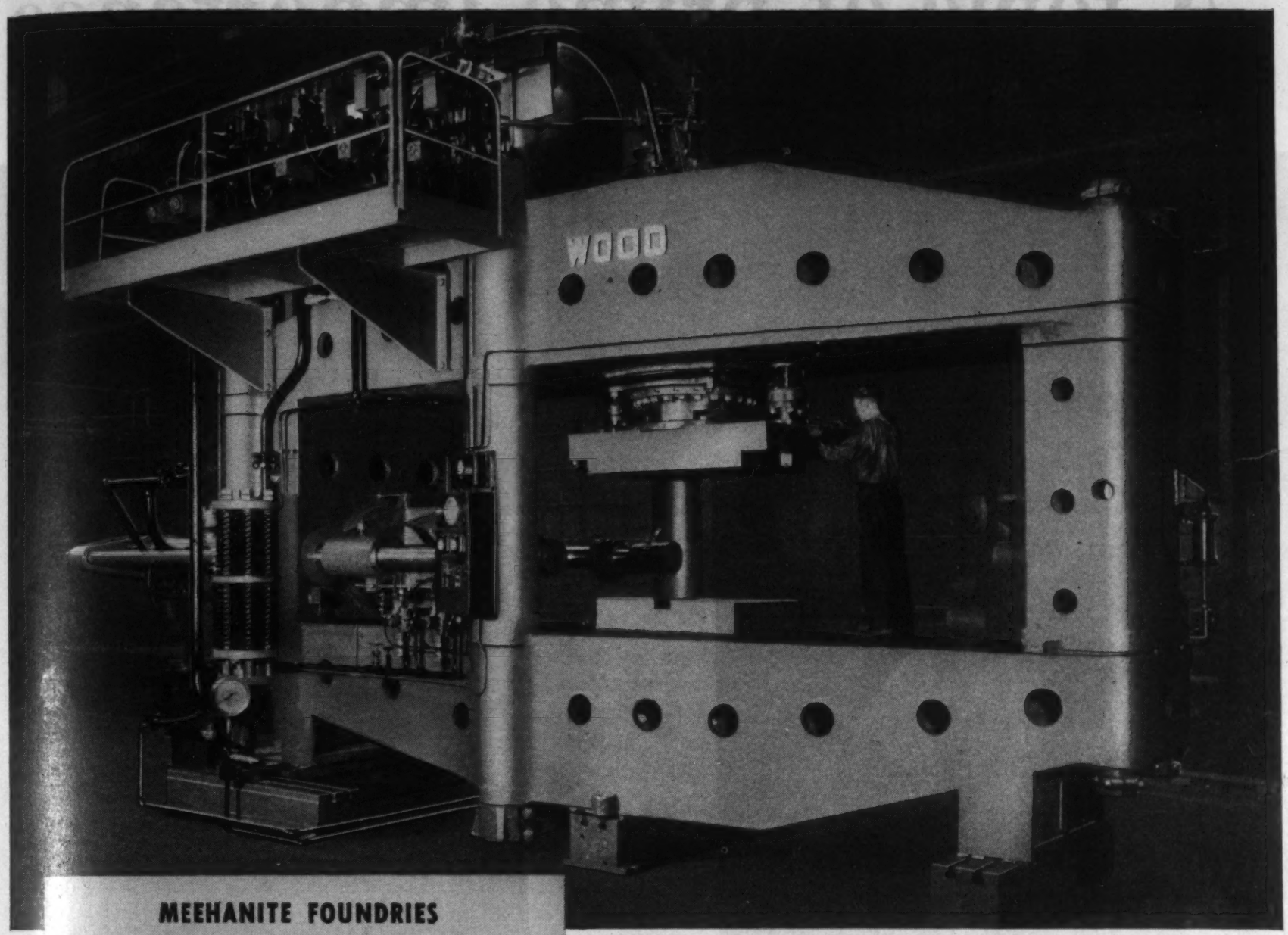
Another very interesting steel of medium alloy content, studied at The Ohio Steel Foundry, is the manganese-molybdenum-vanadium cast steel of analysis range as shown in Table I. This steel also has no NE counterpart, and may therefore be of special interest to foundries interested in high yield strength for castings. The only NE steel that approximates it at all is the NE 9442 analysis.

The curve for the manganese-molybdenum-vanadium cast steel in Fig. 3 is a typical end-quench curve for this class of steel. It has been successfully used to meet specifications calling for 150,000 p.s.i. minimum yield strength and 30% reduction of area. Especially noteworthy is the way this analysis holds its hardness—38 Rockwell "C" at 2 in.—and the slight falling-off of the curve. Needless to say, this steel can be employed in rather heavy sections (5 in.) as well as in light sections, with equally good results.

### *Reference*

[1] Jominy, W. E. and Boegehold, A. L.: "A Hardenability Test for Carburizing Steels." *Trans* A.S.M. Vol. 26, 1938, page 574.

# VITAL PARTS ARE MEEHANITE CASTINGS




*20,575 lb. of Meehanite Castings are used in construction of this upsetting press.*

## . . . IN THIS CUSTOM-BUILT PRESS

At the Pittsburgh Steel Company's addition to its Allenport, Pa., plant for the production of tubular railway axles, the manufacturing process depends mainly upon this large tube upsetting press built by the R. D. Wood Company, Philadelphia, Pa.

As is the case in so many new designs for special equipment, important parts are Meehanite Castings. In this custom-built press the following Meehanite Castings were used:

| Quantity | Part | Finished Weight |
|---|---|---|
| 1 | Horizontal Ram | 11,500 lb. |
| 2 | Pistons | 55 lb. each |
| 2 | Pull Back Covers | 35 lb. each |
| 1 | Vertical Ram | 7,400 lb. |
| 2 | Rollers | 115 lb. each |
| 2 | Rails | 270 lb. each |
| 1 | Stripper Ram | 725 lb. each |

These castings contribute the required high strength, resistance to wear and structural soundness essential to this equipment.

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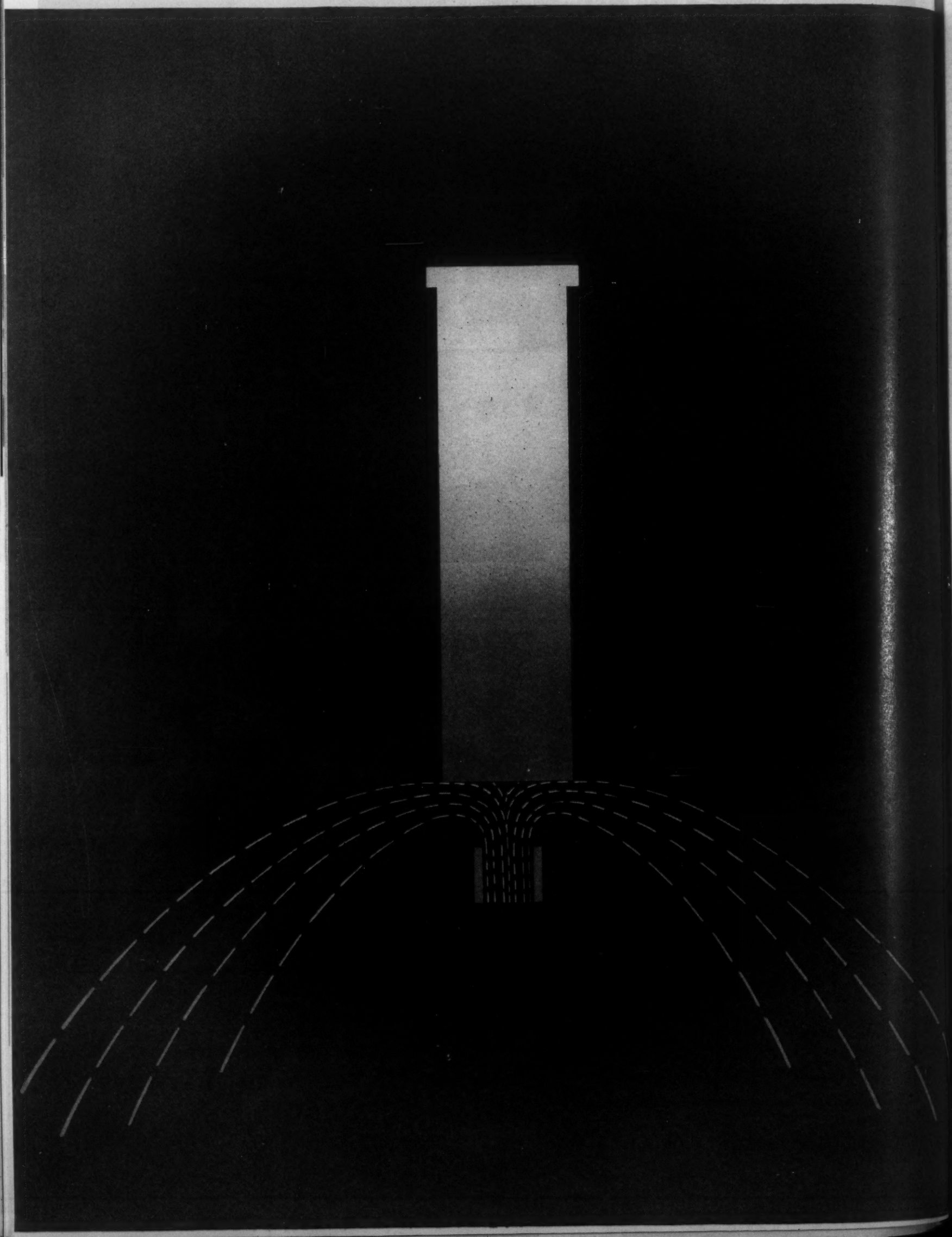
| | |
|---|---|
| Allentown, Pa. | Traylor Engineering Company |
| Ansonia, Conn. | Farrel-Birmingham Co., Inc. |
| Birmingham, Ala. | The Continental Gin Co. |
| Bridgewater, Mass. | The Henry Perkins Co. |
| Brooklyn, New York | E. W. Bliss Company |
| Buffalo, N. Y. | Pohlman Foundry Co., Inc. |
| Charleston, W. Va. | Kanawha Manufacturing Co. |
| Chattanooga, Tenn. | Ross-Meehan Foundries |
| Chicago, Ill. | Greenlee Foundry Company |
| Cincinnati, Ohio | Cincinnati Grinders Incorporated |
| Cincinnati, Ohio | The Cincinnati Milling Machine Co. |
| Cleveland, Ohio | Fulton Foundry & Machine Co. |
| Denver, Colo. | The Stearns-Roger Mfg. Co. |
| Detroit, Mich. | Atlas Foundry Co. |
| Flint, Mich. | General Foundry & Mfg. Co. |
| Hamilton, Ohio | The Hamilton Foundry & Machine Co. |
| Hamilton, Ontario | Otis-Fensom Elevator Co., Ltd. |
| Irvington, N. J. | Barnett Foundry & Machine Co. |
| Jeannette, Pa. | Elliott Company |
| Los Angeles, Calif. | Kinney Iron Works |
| Milwaukee, Wis. | Koehring Company |
| Mt. Vernon, O., Grove City, Pa. | Cooper-Bessemer Corporation |
| New York, N. Y., Mahwah, N. J. | The American Brake Shoe Co. |
| Oakland, Calif. | Vulcan Foundry Company |
| Orillia, Ontario | E. Long, Ltd. |
| Philadelphia, Pa. | H. W. Butterworth & Sons Co. |
| Philadelphia, Pa. | Florence Pipe Foundry & Machine Co. (R. D. Wood Company, Selling Agents) |
| Phillipsburg, N. J. | Warren Foundry & Pipe Corp. |
| Pittsburgh, Pa. | Rosedale Foundry & Machine Co. |
| Portland, Oregon | Crawford & Doherty Foundry Co. |
| Rochester, N. Y. | American Laundry Machinery Co. |
| St. Louis, Mo. | Banner Iron Works |
| St. Paul, Minn. | Valley Iron Works |
| Seattle, Washington | Washington Iron Works |
| Spokane, Washington | Washington Machinery & Supply Co. |

# A topic of prime importance



# to metallurgists today . . .

# HARDENABILITY

## *as a means of determining desired steel characteristics or response to heat treatment*

ONLY a few years ago steel users had but few standards for determining, in advance, steel characteristics and response to treatment. Steel was specified almost entirely on the basis of its chemical composition limits.

To further insure steel quality and uniformity and to provide more reliable forecasts of the steel's physical properties and its suitability for given applications, steel metallurgists have gradually developed ever more accurate methods of determination and treatment.

In this connection U·S·S metallurgists have contributed importantly in such developments as grain size control, the isothermal transformation diagrams, austempering, controlled heat treatment, and most recently, the study of hardenability.

It has been shown that the end-quench hardenability test devised by Jominy and standardized by S.A.E. indicates the following metallurgical features in terms of normal expectancy: (1) maximum hardness—a function of the carbon content; (2) depth of hardness—a function of the alloying content; (3) effect of mass—a function of the cooling rate; (4) probable microstructures and (5) approximate physical characteristics.

It is because so much can be determined by a wise interpretation of each of these phases that hardenability is being so carefully studied in metallurgical circles today.

Our metallurgists are available for discussion of this subject in detail.

# U·S·S Carilloy Alloy Steels

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METALS and ALLOYS
Engineering File Facts

NUMBER 49
June, 1944

GENERAL ENGINEERING DATA

# An Outline of Testing Methods

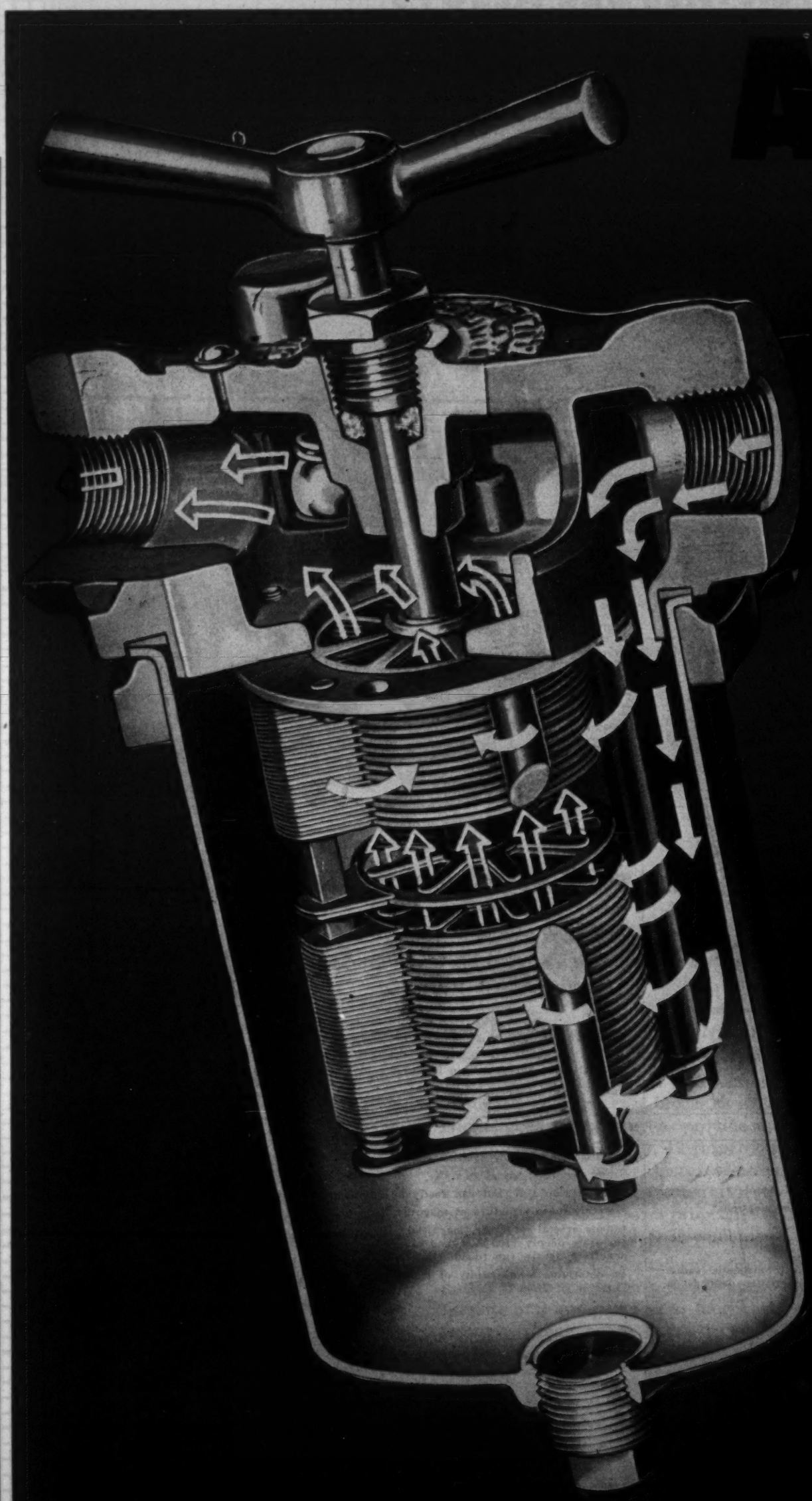
*Table 1—Destructive Testing*

| *Method* | *Property Used* | *Applications* |
|---|---|---|
| | *(a) Chemical Analysis* | |
| [1] Qualitative and quantitative | Determine ions ($Fe_2$, $Fe_3$, $SO_4$) present | General chemical analysis, used for routine and special work |
| [2] Organic | Determine C, $H_2$, $O_2$, $N_2$, etc. | To analyze qualitatively and quantitatively organic compounds |
| [3] Spectrographic, spectroscopic | Shows spectrum of "excited" elements | A micro-method, small amounts of sample necessary. Permits rapid determinations. |
| [4] X-ray diffraction, electron diffraction | Position and type of atoms give a typical spectrum | To identify compounds and elements, structure, etc. |
| [5] Micro analysis | Special reactions | Use very small amounts of sample |
| [6] Spot analysis | ——— | ——— |
| [7] Electrochemical analysis | Deposit ions at cathode or anode | Rapid quantitative method using d.c. current |
| [7] Polarographic and micropolarographic | Automatic recording of current voltage curves | Rapid quantitative and qualitative analysis |
| [8] Colorimetric | Light transmittance of solutions | Various techniques use photoelectric cells, etc. |
| [9] Polarized light | Differential coloring of compounds | Used in analysis of slags; also in metallography and special tests |
| [10] Magnetic, electro-magnetic electrical resistance | Properties of metals and alloys vary | Used for rapid analysis of carbon in steels, etc. |
| [11] Spark testing | Sparking characteristics | Used for identification of metals |
| | [12](*b*) *Physical (or mechanical) Properties* | |
| [23a]Tensile | Strength and deformation | Obtain values of engineering significance |
| Micro-tensile | Strength and deformation | Micro samples |
| Hardness | (a) resistance to indentation<br>(b) resistance to scratching | Brinell, Rockwell and Vickers from file to micro-character |
| Microhardness | ——— | A notch sensitive test; (very arbitrary) |
| Impact | Resistance to shock | For materials subjected to varying stresses |
| Fatigue | Endurance | Shafts, rivets, holding plates together, etc. |
| Torsion | Resistance to twist | Wire, sheets, welds, etc. |
| Bend | Alternate tension and compression | ——— |
| Creep | Deformation of metals | In relation to time and temperature |
| Damping | Internal friction and directional properties | Dissipation of energy within material |
| Tear | " | Particularly in sheets |
| | (c) *Metallographic* | |
| [13] Dilatometry | Changes in volume | Investigation of alloy systems |
| [14] Macroscopy | Reflection from etched surfaces | Grain structure, visual to 5 X |
| [15] Microradiography | Absorbing power of metal | Magnification 1 X, but can easily be enlarged to 100-250 X |
| [16] Electron microscope | Opacity to beams of electrons* | Metallographic structure at magnifications of 5000-30,000 X |
| [17] Diffraction<br>(a) X-rays<br>(b) electron beam | Diffraction | Atomic crystal structure, magnitude $10^{-8}$ cm.<br>penetrate deeply (100 A.u. and more)<br>penetrate lightly (up to 50 A.u.) |
| [18] Radiography<br>(a) X-rays<br>(b) gamma rays | Absorption of electro-magnetic radiation; (opacity) penetration depends on wave length | To determine homogeniety of material, etc. Usually natural size<br>Location of flaws. |
| [19] Stereo-radiography | " | |
| [30] Irreversible potentials | Electrode potentials | Studies on solid solubility, diffusion, age hardening, etc. |
| [20] Corrosion | Chemical affinity | Many methods in these tables used |
| [21] Hardenability<br>(a) McQuaid-Ehn test<br>(b) Jominy end quench<br>(c) Burns, Moore & Archer S-A-C<br>(d) Shephard P-F<br>(e) Cathode ray Oscillograph | Reaction to quenching | ——— |
| [21b]Magnetic torque | Magnetic properties | Study orientation in deep-drawing steel |

* Note: A special technique is required to obtain samples of metal structures for electron microscope examination.

(Continued on page 1432)

# A Trip



The filter element consists of a stack of flat wheel-shaped discs, each separated from the next by a thin metal spacer. Discs and spacers are fixed on a central rotatable shaft, with the "spokes" positively aligned so that the open areas between them form channels lengthwise within the cartridge.

The fluid from the filter inlet surrounds the cartridge and is forced by differential pressure to flow radially through the slots between discs. Solids larger than the slot openings are retained on the outer edges. The filtered fluid continues up through the central channels to the filter outlet.

When the filter is to be cleaned, the cartridge is rotated past knife-like stationary cleaner blades, slightly thinner than the spaces, which extend into the slots as far as the inside edge of the disc rims. All accumulated solids are combed out and settle to the bottom of the sump.

# through a filter

Fluid's-eye view of a fluid-cleaning method that handles full flow without ever a stop for filter-cleaning

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***Full flow***—A Cuno Auto-Klean no larger than the ordinary partial-flow type, handles full flow of fluid.

***Continuous operation***—Auto-Klean can be cleaned without stopping fluid flow. No expensive space-consuming duplex installation needed.

***Minimum pressure drop***—The Auto-Klean is applicable to low pressure or gravity feed systems, as well as others.

***Minimum maintenance***—In an Auto-Klean, the filter element is permanent. There is nothing to replace, nothing to renew.

***Long life***—The Auto-Klean—all-metal, non-collapsible—will last as long as the equipment on which it is installed.

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- ☐ Enamel
- ☐ Engine Fuel
- ☐ Engine Lubricating Oil
- ☐ Fuel Oil
- ☐ Fuel Tar
- ☐ Gases
- ☐ Gasoline
- ☐ Grease
- ☐ Grinder Coolant
- ☐ Hydraulic Oil
- ☐ Japan
- ☐ Lacquer
- ☐ Lubricating Oil
- ☐ Machine Tool Cutting Oil
- ☐ Machine Tool Hydraulic Oil
- ☐ Machine Tool Lubricating Oil
- ☐ Nitrocellulose Solutions
- ☐ Oils
- ☐ Paint
- ☐ Pyroxylin
- ☐ Quenching Oil
- ☐ Resins
- ☐ Rust Proofing Compounds
- ☐ Sizing
- ☐ Solvents
- ☐ Spray Systems
- ☐ Tar
- ☐ Test Stand Lubricating Oil
- ☐ Varnish
- ☐ Washing Compounds
- ☐ Water
- ☐ Wax

*Name*.....

*Company*.....

*Address*.....

NUMBER 49 (Continued) AN OUTLINE OF TESTING METHODS

*Table II—Non-Destructive Testing*

| *Method* | *Property Used* | *Applications* |
|---|---|---|
| | *Chemical* | |
| [11] Spark test | Characteristic spark of metals | Classification and identification |
| [6] Spot test | Metallo-organic reactions | Detection of metals |
| Fluorescence | Metal surface appearance changes | Selection of stainless steel, Mo, Ta and Ni scrap |
| [28] Surface analysis | Sulphur prints, etc. | Inclusions in steel and other metals |
| [20] Corrosion | Chemical affinity | Field test and pilot plant scale |
| | *Physical* | |
| [23] Scleroscope | Rebound hardness | Finished parts, roller bearing ball |
| Stroboscope | High frequency light flicker | Stressed members in motion |
| [24] Magnetic | Decrease in attraction of permanent magnet | Measure thickness of non-magnetic coating on iron or steel |
| [29] Cyclograph | Core losses | Production quality control: case depth, plating thickness, carbon content, etc. |
| [25] Strain coat | Brittle lacquer | Strains on members |
| [31] Metal deformation | Photo-grid printing | Measure deformation in metals over short gage lengths |
| Acoustic | Transmission of sound | Stethoscope used on castings and welded structures |
| Ultra-sonic | High frequency sound | Detectoscope, ditto and large ingots |
| [26] Magnetic (powder) (a) as such [26a](b) fluorescent | Magnetic permeability, even flux | Surface cracks, non-metallic inclusions in castings, etc. (a) on magnetic; (b) on non-magnetic materials (Magnaglo, Zyglo; G. E.) |
| [27] Farrow test | Electrical conductivity | Welded tubing in aircraft (Sperry) |
| [27] Electrical | Electrical conductivity | Detection of flaws in tubing, up to 5 ft. in diam. |
| Hydrostatic | Water pressure applied | Reveals such defects as will show leaks |
| [18] Radiography (a) X-ray (b) gamma ray (c) stereoradiography (d) X-ray counting tubes (e) Ultra-high speed | Penetration through opaque body 15-1000 kilovolts<br>Double exposure<br>Geiger Müller<br>X-rays at 1000+ amps. for micro-seconds | Examination of ferrous and non-ferrous castings and welds. For quality of products and to improve technique of production<br>Test for flaws and irregularities in steel cylinders and tanks<br>Ballistics, spot welding, impact testing. |
| [34] Profilometer | | Surface irregularities |
| [32] Visual inspection | Training and experience | Surface appearance |

References:

(1) *Many texts available. Some of the better known are: "Standard Methods of Chemical Analysis," Scott et al,* 1939; *"Sampling and Analysis of Carbon and Alloy Steels," U. S. Steel Corp.,* 1938; *Analytical Chemistry, Treadwell, Vol. I,* 1937; *Vol. II,* 1942. (2) *"Commercial Organic Analysis," Allen, 5th Ed.* 1923-1933; 10 *vol.; "Systematic Identification of Organic Compounds," Shriner & Fugon,* 1940; *"Analytical Chemistry of Industrial Hazards, Poisons and Solvents," Strain,* 1942; *Mullikan-Huntress, "Manual of the Identification of Organic Compounds,"* 1937. (3) *"Index to Literature on Spectrochemical Analysis," A.S.T.M.,* 1941; *Twyman, "Spectrochemical Analysis of Metals."* (4) *Clark, "Applied X-Rays,"* 1940; *Buerger, "X-Ray Crystallography,"* 1942; *"Alphabetical and Formula Index of X-Ray Diffraction Data Cards," A.S.T.M.,* 1942. (5) *"Introduction to Microtechnique Inorganic Analysis," Pilcher,* 1942. (6) *Feigl, "Qualitative Analysis by Spot Tests,"* 1939. (7) *Kolthoff & Lingane, "Polarography,"* 1941; *Müller, "The Polarographic Method of Analysis,"* 1941; *Slowin, "Rapid Quantitative Electrolytic Method of Analysis,"* 1941. (8) *Snell & Snell, "Colorimetric Methods of Analysis,"* 1936. (9) *Gibb, "Optical Methods of Chemical Analysis,"* 1942; *Chalmers, "Physical Examination of Metals," Vol. I,* 1939. (10) *Chalmers & Quarrel, "Physical Examination of Metals," Vol. II,* 1942; *Rogers, Wentzel & Riott, A.S.M. Preprint,* 1941. (11) *Pitois, "Sparking of Steel,"* 1929; *Pulsifer, "Inspection of Metals,"* 1941. (12) *Troxell, Davis & Wiskocil, "Testing and Inspection of Engineering Materials,"* 1942, *"A.S.T.M. Standards," Vol. I,* 1943; *Frocht, "Photoelasticity,"* 1941; *Steinitz, METALS AND ALLOYS, Vol.* 17, *June* 1943, *p.* 1183; *etc.* (12[a]) *Brodie, "The Microhardness Tester," A.S.M. Preprint,* 1943. (13) *Chevenard, "Analyse Dilatrometrique des Materiaux,"* 1929; *Stanton, "A Recording Dilatometer for Metal," Iron & Steel Inst. (London),* 1942. (14) *"A.S.T.M. Standards,"* 1942, *Vol. I, Metals; Vilella, "Metallographic Technique for Steel,"* 1937; *A.S.M. "Metals Handbook,"* 1941; *"Metallographers' Handbook of Etching," Berglund,* 1935. (15) *Gross & Clark, Ind. & Eng. Chem., Vol.* 14, 1942, *p.* 676; *Woods & Cetrone, METALS AND ALLOYS, Vol.* 18, *Dec.* 1943, *p.* 1320. (16) *Barnes & Burton, A.S.T.M., Bull., May* 1942, *p.* 34. (17) *Barrett, "The Structure of Metals,"* 1943. (18) *St. John & Isenburger, "Industrial Radiology,"* 1943. (18[a]) *Canadian Radium Corp.* (19) *Ridbey, "On the Location of Flaws by Stereoradiography," A.S.M. Preprint,* 1942. (20) *A.S.T.M. "Symposium on Corrosion Testing Procedures,"* 1937; *Evans, "Metallic Corrosion, Passivity and Protection,"* 1937. (21) *Hardenability of Alloy Steel," A.S.M. Symposium,* 1939. (21[b]) *Stanley, Metals Tech., Sept.* 1943, *TP No.* 1635. (23) *O'Neill, "The Hardness of Metals and its Measurement,"* 1934; *Williams, "Hardness and Hardness Measurement,"* 1942. (24) *Chalmers & Quarrel, "Physical Examination of Metals," Vol. II.* 1942; *Rogers, Wentzel & Riett, A.S.M. Preprint,* 1941, *No.* 11. (25) *Magnaflux Corp. literature.* (26) *Doane, "Principles of Magnaflux Inspection,"* 1940; *Doane & Thomas, "Magnaflux Aircraft Inspection Manual,"* 1941. (26[a]) *de Forest, A.S.M. Preprint No.* 19, 1942. (27) *Knerr, METALS AND ALLOYS, Vol.* 12, *Oct.* 1940, *p.* 464. (28) *Hunter, Churchill & Mears, Metal Progress, Vol.* 43, *Dec.* 1942, *p.* 1070. (29) *Allen B. Dumont Labs., Inc.* (30) *Brown, Fink & Hunter, A.I.M.E.,* 1940, *TP No.* 1234. (31) *J. Aeron. Sci., Nov.* 1941. (32) *Enos, "Visual Examination of Steels,"* 1940. (33) *The Iron Age, June* 10, 1943, *p.* 70. (34) *Swigert, "The Story of Superfinish,"* 1940.

*Compiled by F. R. Morral*
*Mellon Institute of Industrial Research*

METALS and ALLOYS
Engineering File Facts

NUMBER 50
JUNE, 1944



# The Damping Capacity of Engineering Materials

In a paper[1] entitled "The Damping Capacity of Engineering Materials," (by Hatfield, Stanfield and Rotherham) some information of importance to design engineers was presented. As this subject is of wide interest in this country, the practical items of this paper are abstracted as an "Engineering File Facts" page; the British units and terminology have been converted to those more commonly used in this country and the tabulations of research data have been reduced to include only the more practical items of direct value to designers and builders of machinery and machine tools.

The term "damping" is used to denote the ability of a material to restrict or resist the transmission of mechanical vibrations. A high degree of damping, then, indicates that the vibrations are almost totally absorbed rather than transmitted. And "damping capacity" is defined as the ratio of energy loss per cycle to the maximum energy of the vibration. This loss of energy occurs at stresses well below the fatigue limit of the material and apparently can continue for an indefinite number of vibrations or oscillations.

The practical importance of the study of damping is reflected in the following comments:

(1) It has been shown that, for certain types of crankshafts, a steel of relatively low fatigue limit and high damping capacity has a longer life than a higher tensile steel of low damping capacity, even though the latter material has a higher fatigue limit.

(2) The large number of high speed rotating parts used in modern military equipment and in civilian machinery (such as propeller shafts for ships, propeller and fan blades, turbine and supercharger parts, centrifuging machinery, precision machine tools and dynamic balancing equipment) requires careful selection of materials in order that objectionable vibration be eliminated or controlled as far as possible.

(3) If serious vibration occurs in a particular design there are several remedial courses open: one is to modify the natural frequencies of the various component parts by changing their dimensions (this alters their stiffness); special damping mechanisms (shock mounts, shock absorbers, etc.) may be used; the work speed may be altered; the assembly may be redesigned (to subdivide the structure); or the material may be changed to others having higher damping capacities.

As a very brief summary of the author's research into this problem of the damping capacity of engineering materials, the following statements can be made:

1. Unless the damping capacity of a given material is considerable, the frequencies of vibrations transmitted by this material will not be measurably affected.

2. The energy loss per cycle for a given range of stresses in a particular material is substantially constant over a wide range of speeds (speed of rotation of the vibrating part).

3. The effects of temperature variations on damping capacity are varied. For one low carbon steel (the first one in Table II) the damping capacity increases (at a given stress level) from 10 to 20 times as the operating temperature is increased from 70 to 1110 F. The other carbon steels were examined at temperatures varying from 70 to 925 F. and their damping capacities did not vary appreciably. The nickel steels exhibited a change in their damping capacities of 3 to 5 times as their respective operating temperatures were increased to 925 F. The damping capacities of the other ferrous materials listed in Table II do not vary greatly within the temperature range investigated (70 to 750 F.).

4. Austenitic alloys show relatively low values of damping capacity, while the 13% chromium stainless steels have high values.

5. The rate of decay of the amplitude of torsional oscillations was used as the measure of damping capacity, but other methods of applying stresses could have been used (tensile and compressive, or bending stresses).

A tabular summary of some of the experimental data obtained by Hatfield, Stanfield and Rotherham follows. Table I shows the damping capacities exhibited by some miscellaneous materials at several levels of stress intensity. A brief description of some of the common metallic materials tested and their damping capacities are given in Table II. In these tabular summaries, only a representative selection of data is reported so that an indication of the range of damping in a specific type of material is indicated. The accuracy of the data reported is given as 2.5% by the authors.

**Table I**

*The Damping Capacities of Some Miscellaneous Materials*

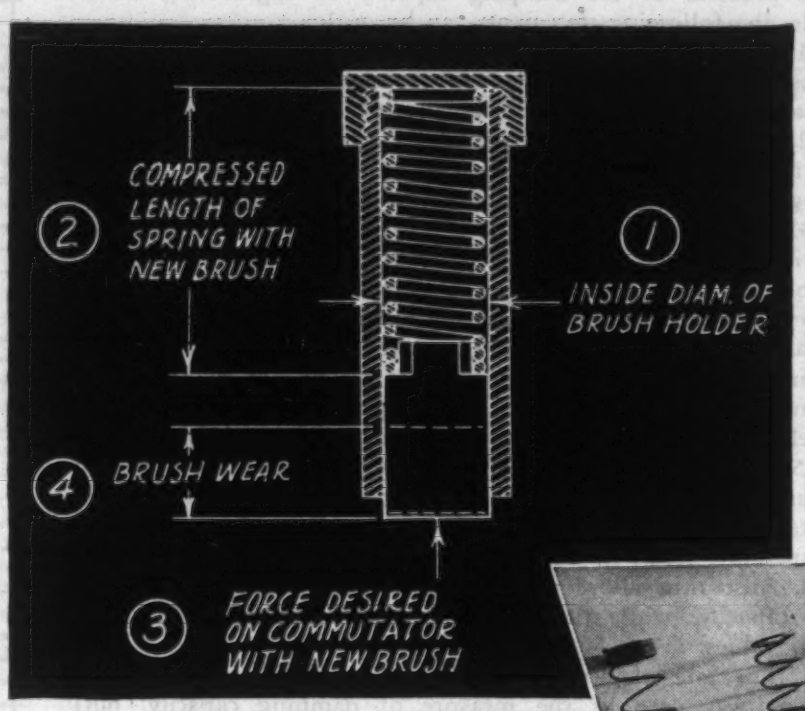
| Type of Material | Max. Tensile Stress, p.s.i. | Per Cent Damping per Cycle at a Stress (p.s.i.) of | | | | | |
|---|---|---|---|---|---|---|---|
| | | 100 | 200 | 300 | 500 | 700 | 1000 |
| Lead | 1,820 | 21.48 | 22.72 | 25.36 | — | — | — |
| Solder (66% Sn, 33% Pb) | 6,360 | — | 29.36 | 30.36 | 31.72 | 33.68 | — |
| Plate Glass[2] | 6,750 | — | — | — | — | — | 1.71 |
| Bakelite (wood flour filler) | 8,700 | — | 25.36 | 20.38 | 21.28 | 19.92 | — |
| Bakelite (coarse fabric filler) | 11,650 | 21.1 | 21.0 | 21.0 | — | — | — |
| Bakelite (paper filler) | 9,600 | 24.8 | 22.6 | 22.0 | 19.6 | — | — |
| Bakelite (fine fabric filler) | 16,150 | 24.28 | 19.8 | 19.32 | 18.48 | — | — |

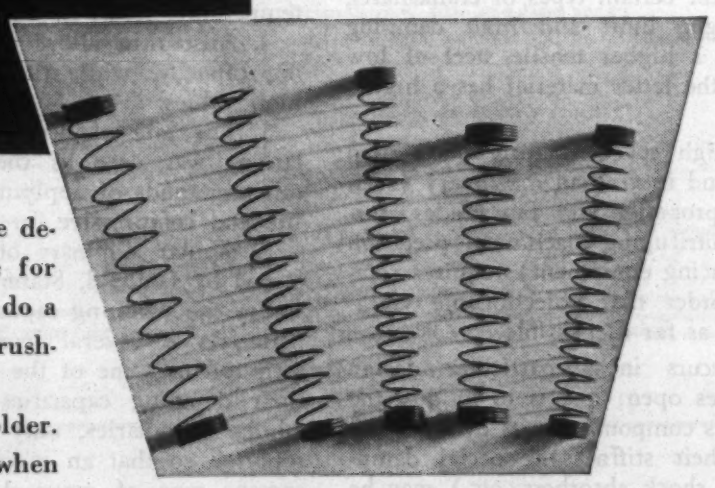
[1] *Read at the May 15, 1942 Meeting of the North-East Coast Institution of Engineers and Shipbuilders at Newcastle-upon-Tyne, England.*
[2] *Plate glass sample was ground, polished and annealed before testing.*

(Continued on page 1437)

# 2 Weeks Delivery on Micro-Processed Brush Springs

## Samples (including re-design if required) in 4 to 5 days



Instrument Specialties engineers have devised a simplified design procedure for determining the best brush spring to do a specific job; based upon only four brush-holder design details:

1 — Inside diameter of brush holder.
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FIELD ENGINEERING OFFICES: BOSTON • CHICAGO • CLEVELAND • PHILADELPHIA • NEW YORK

Table II

*Damping Capacities and other Pertinent Data of Some Common Engineering Materials*

| Type of Material | Heat Treatment Prior to Testing | Composition, Per Cent | | | | | | Mechanical Properties | | | | | Per Cent Damping Per Cycle at a Stress (in p.s.i.) of | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | C | Mn | Ni | Cr | Si | Others | BHN | YP, p.s.i. | El., % | R.A. % | Izod, ft-lb | 4500 | 6700 | 8950 | 11,200 | Others |
| Carbon Steels, (Bar) | Norm. at 1690 F. | .09 | 0.22 | 0.10 | 0.09 | 0.18 | — | 107 | 35,000 | 37 | 62 | 85 | 0.84 | 1.50 | 2.10 | 2.62 | — |
| (Bar) | Norm. at 1690 | 0.10 | 0.26 | 0.14 | 0.05 | 0.23 | — | 112 | 32,500 | 37.8 | 59.8 | 83 | 2.28 | 2.78 | 3.36 | 4.16 | — |
| (Bar) | Norm. at 1690 | 0.26 | 0.56 | 0.13 | 0.05 | 0.17 | — | 138 | 49,250 | 30 | 58 | 50 | 1.08 | 1.70 | 2.00 | 2.40 | — |
| Nickel steels (Bar) | O.Q. 1560; T. 1200 | 0.31 | 0.53 | 3.10 | tr. | 0.19 | — | 250 | 72,000 | 23.3 | 59.2 | 60 | 0.60 | 0.64 | 0.72 | 0.92 | — |
| (Bar) | O.Q. 1525; T. 1025 | 0.21 | 0.48 | 4.98 | tr. | 0.21 | Mo 0.06 | 270 | 111,000 | 24 | 65.5 | 92 | 0.48 | 0.61 | 0.86 | 1.30 | — |
| Ni-Cr steels (Bar) | O.Q. 1525; T. 1200 (WQ) | 0.30 | 0.56 | 3.62 | 0.73 | 0.14 | — | 274 | 109,500 | 19 | 66.5 | 70 | 0.38 | 0.49 | 0.60 | 0.70 | — |
| (Bar) | A.C. 1490; T. 390 | 0.28 | 0.45 | 4.35 | 1.39 | 0.21 | — | 465 | 202,000 | 14 | 50 | 25 | 0.50 | 0.51 | 0.52 | 0.56 | 0.69[1] |
| Ni-Cr-Mo Steel (Bar) | (Oil quenched and temp.) | 0.29 | 0.50 | 3.48 | 0.72 | 0.26 | Mo 0.37 | — | 149,000 | 21 | 63 | 55 | 0.22 | — | 0.28 | — | 0.52[1] |
| Stainless irons | O.Q. 1830; A.C. 1380 | 0.12 | 0.25 | — | 12.92 | 0.20 | — | 183 | 54,000 | 32 | 70 | 80 | 8.0 | 8.0 | 8.0 | 8.0 | — |
| | O.Q. 1740; W.Q. 1345 | 0.13 | 0.29 | 0.33 | 13.52 | 0.31 | — | 201 | 72,500 | 30 | 73 | 119.5 | 0.88 | 1.40 | 2.17 | 2.85 | — |
| Stainless steels | O.Q. 1780; W.Q. 1400 | 0.24 | 0.35 | 0.19 | 14.18 | 0.61 | — | 223 | 78,200 | 28 | 66.5 | 100 | 2.76 | 4.80 | 6.28 | 7.23 | — |
| | O.Q. 1760; W.Q. 1310 | 0.27 | 0.31 | 0.37 | 13.16 | 0.30 | — | 226 | 82,200 | 28.5 | 67 | 99 | 0.44 | 0.64 | 0.94 | 1.17 | — |
| | Air cool from 1920 | 0.11 | 0.35 | 8.46 | 18.70 | 0.72 | Al 1.52[11] | 255 | 86,000 | 34 | 64 | 85 | 0.76 | 1.16 | 1.64 | 3.8 | — |
| | Air cool from 1740 | 0.10 | 0.77 | 20.42 | 25.74 | 1.54 | Ti 0.63 | 195 | 60,800 | 36 | 50 | 96 | 0.30 | 0.36 | 0.44 | 0.6 | — |
| Cast irons | Tested as received | 3.26[2] | 0.41 | Cu 0.11 | 0.04 | 1.79 | Ti 0.09 | — | 26,500 | 0.1 | nil | nil | 8.00 | 10,48 | — | — | 6.24[5] |
| | Tested as received | 3.18[3] | 0.51 | — | 0.05 | 1.83 | V 0.14 | — | 23,400 | 0.1 | nil | nil | 19.1 | — | — | — | 14.7[5] |
| | Tested as received | 3.71[4] | 0.52 | 0.02 | 0.04 | 1.95 | Cu 0.08[12] | — | 11,900 | 0.41 | nil | 0.50 | 28.0 | 40.0 | — | — | 16.0[5] |
| Sintered carbides | Tested as received | Tungsten carbide with 6% cobalt | | | | | | (6) | — | — | — | — | — | — | 0.62 | 0.67[7] | 0.86[8] |
| | | Tungsten carbide with 13% cobalt | | | | | | (6) | — | — | — | — | — | — | 0.60 | 0.87[7] | 1.40[8] |

| Type of Material | Treatment or Condition | Composition, Per Cent | | | | | | | BHN | YP, p.s.i. | El., % | R.A. % | Izod, ft-lb | % Damping, at a Stress of | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Cu | Al | Fe | Zn | Sn | Mn | Others | | | | | | 2250 | 4500 | 6700 | Others |
| Magnesium alloys | Extruded bar | 0.02 | 6.09 | tr. | 0.97 | — | 0.33 | Mg. bal. | 77 | 34,100 | 7 | 12 | 3 | 0.72 | — | — | 0.31[9] |
| | Sand cast | 0.07 | 4.69 | — | 0.22 | — | 0.15 | Mg. bal. | 60 | 8,080 | 6.5 | 7.5 | 1 | 2.85 | — | — | 0.63[9] |
| Aluminum alloys | Heat 12 hr. at 275 | 4.73 | Bal. | 0.23 | — | — | — | — | 101 | 26,900 | 7 | 12 | 2 | 0.49 | — | 0.77[10] | 0.83[9] |
| Copper-tin alloy | Tested as received | 94.18 | — | tr. | tr. | 5.42 | — | — | — | 15,900 | 17.5 | 20 | 54 | 0.39 | 0.46 | 0.49 | — |
| Copper-zinc alloys | Tested as received | 58.45 | 1.13 | 0.87 | 37.57 | 0.37 | 1.00 | Ni 0.13[13] | 135 | 35,000 | 17.5 | 19 | 12 | 0.25 | 0.39 | 0.55 | — |
| | Tested as received | 56.55 | 0.18 | 0.79 | 41.22 | 0.82 | 0.20 | Ni tr.[14] | 136 | 35,900 | 29.5 | 29.5 | 19.5 | 0.40 | 0.50 | 0.86 | — |
| | Tested as received | 51.93 | 0.21 | 0.70 | 47.13 | tr. | 0.32 | Ni tr. | 135 | 19,700 | 22 | 23 | — | 0.32 | 0.34 | 0.54 | — |

*[1] These values of damping were determined at 22,400 p.s.i. torsional stress; [2] carbon (total), 3.26%; carbon (graphite) 2.45%; S 0.13 and P 1.03%; [3] carbon (total) 3.18%; carbon (graphite) 2.33% S 0.092% and P 1.15%; [4] carbon (total) 3.75%; carbon (graphite) 2.93%; S 0.090% and P 0.092%; [5] these values were obtained at 2240 p.s.i.; [6] 1450 and 1070 DHN, respectively; [7] this value obtained at 13,400 p.s.i.; [8] this value obtained at 17,900 p.s.i.; [9] these values were obtained at 1000 p.s.i.; [10] this value was obtained at 3500 p.s.i.; [11] contains 0.86 Ti; [12] contains 0.07 Ti; [13] contains 0.23 Pb; [14] contains a trace of Pb.*



Compiled by Robert S. Burpo, Jr.

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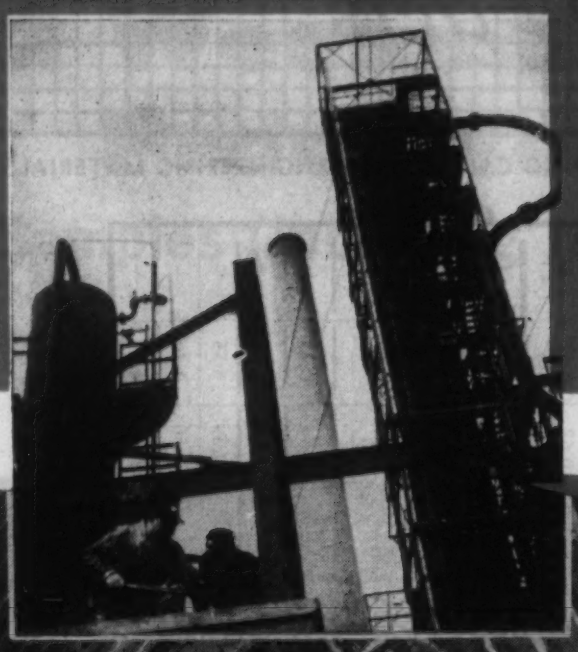

This photograph was taken inside a clay tower lined with straight chromium sheets welded with Arcos Chromend HC electrodes by an oil refinery. The particular grade, chosen to meet the specifications required by this job, is one of the 42 available analyses on the regular production list of Arcos electrodes. ★ Fabricators are more and more looking to the complete line of Arcos Stainless and Alloy electrodes as the quick, sure answer to the successful welding of stainless equipment. ★ Get in touch with your Arcos distributor on your next stainless welding job.

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# METALLURGICAL ENGINEERING shop notes

## Versatile Spatter-Proof Liquid

*by Ross Yarrow,*
*Republic Structural Iron Works*

In the fabrication of welded steel bases designed with numerous ribs welded at right angles to steel plates, the cleaning of weld spatter was a considerable item in our labor costs. This was remedied somewhat by using a spatter-proof liquid, a proprietary product.

We brushed it on the steel, covering about 2 in. on each side of the weld. Since this was slow, we designed a simple spray to eliminate the brushing. We cut a ¼-in. pipe with a hack saw far enough to permit easy bending. We bent the pipe at 90 deg. and attached a short piece of rubber hose, with the bottle of liquid at the other end. The spray worked on the suction principle.

Then, another use for the spatter-proof liquid was found. After the bases are fabricated, they are given a stress relief heat-treatment in a furnace, bringing up to 1200 F., holding for 2 hr., cooling slowly in still air.

The treatment removes shrinkage stresses in the welded steel, but leaves an oxide film and makes mill scale harder to remove. However, the spatter-proof liquid left mill scale much looser and oxide scale much easier to remove. Now all structures are sprayed completely both before and after welding.

Instead of the usual cleaning time per base after heat treatment of 3 hr., the period has been reduced to 1¾ hr., and the surface is much cleaner and smoother for the priming coat of paint.

A final advantage of the protective liquid is that if the bases are left outdoors for several days, awaiting heat-treating, the surface is protected from rusting.

---

*To overcome recurrent shortage of zinc, vital in the production of aircraft carburetors, the materials department, with the aid of Bendix distributors the nation over, launched a new wrinkle in salvage by buying up used and junked automotive carburetors. From these worn-out parts, the plant now obtains 10,000 lb. of zinc and about 5,000 lb. of aluminum per month for use in the corporation's Sounth Bend foundry and die-casting departments.*

—H. F. Bundy, Bendix Products Div., Bendix Aviation Corp.

---

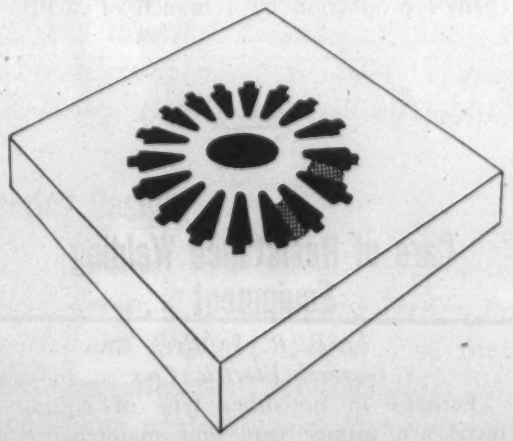
## Blanking Die Reclaimed by Welding

*by Pete Marose*

A blanking die in the plant of the New Monarch Machine & Stamping Co. broke in the press during a punching operation and a new die would have taken three weeks to make at a cost of approximately $200. The foreman of the plant asked about the possibility of repairing the break by arc welding, and it was decided to try it out on this tool steel die.

Taking the die apart, we V'ed out the breaks and placed the die in the oven at 300 F., at the same time placing in the oven a piece of cast iron block. After both were thoroughly heated, we took them out and, placing the die on the block so that it would not cool too rapidly, we proceeded to weld the breaks with a ⅛-in. tool steel electrode with the welder set at 100 amp.

We would weld a small bead at a time, peening each weld thoroughly as we went along until the break had been filled. We then placed the die back in the oven and draw-dipped in oil to harden.



After grinding and placing back in the press, the entire repair bill had cost $10.

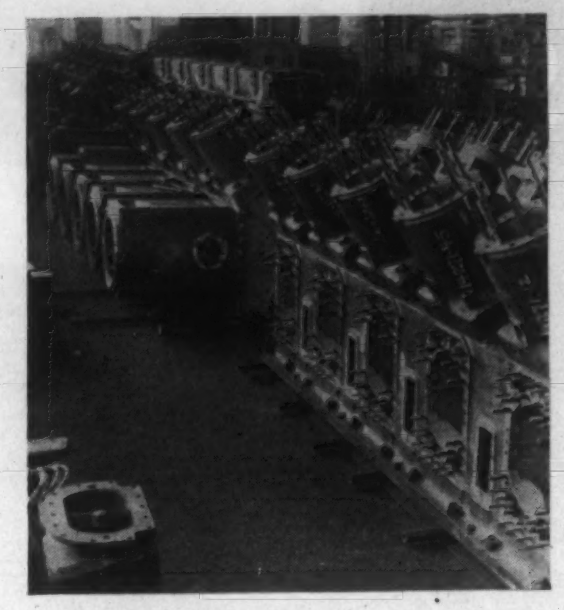
Our repaired die is still in operation and has since turned out over 500,000 steel and 300,000 fibre stampings.

(Drawing and Data, Courtesy: The Hobart Brothers Co.)

## Compressor Assembly by Tracks and Skids

*by Robert Humphreys, Cooper-Bessemer Corp.*

Conventional methods of assembly, involving the use of overhead cranes and hauling, were discarded in the case of 56-ton compressors at the plant of the



Cooper-Bessemer Corp., Mt. Vernon, Ohio. It is said to be the only assembly line type of production ever attempted for turning out engines of this size. We roll the engine to the parts instead of transporting the parts to the engine.

The novel idea consisted of embedding steel tracks in the erecting floor and mounting steel skids on the engine bases so that the huge units can be rolled from station to station.

In the accompanying photograph progressive assembly operations of these 1000-h.p. compressors are depicted from the engine frame in the foreground to completely assembled GM-V units in the background.

Various component parts are located at selected areas along the line where they will be needed in the assembly. This method is in large part responsible for favorable comments made on the company's production by a branch of WPB.

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## Care of Resistance Welding Equipment

*by E. R. Spittler, General Electric Co.*

Perhaps in no other type of equipment are proper care and maintenance more important than in production resistance welding equipment. Here are what might be termed the "Ten Commandments" in such care.

If the welding transformer is water-cooled, be sure that water circulates freely throughout operation; remove dirt, dust and grit from transformer and secondary circuit at least once a week (An accumulation of flash particles will cause a short circuit in the transformer windings, thus reducing efficiency, increasing operating costs and perhaps causing windings to burn out.)

Switches, contactors and timing devices are the nerve centers that control the operation of a welder, and it must be in good condition, mechanically and electrically. They should be checked every two months for wear, such as oxidation at fuse connections in switches, loose electron tube sockets and loose wiring in timing devices.

Electrodes, welding wheels, dies or mandrels that have become burned or pitted with steel are a constant source of trouble. Frequently refacing the working surfaces of these electrodes is wise All electrodes and welding dies should be cooled; if by water, a full flow should always be maintained while operating.

Clamps and fixtures should be inspected closely and adjusted frequently. So should motors, variable-speed drives, clutch and reduction units, transmission gears and shafts, the frequency of inspection depending on production load.

All moving parts must be oiled and greased regularly, but avoid dropping oil or grease on electrical wiring or connections. Devices for establishing welding pressure, such as air or hydraulic cylinder, or a cam or toggle with spring arrangement, should be inspected periodically and kept in perfect condition always. All air and oil filters should be cleaned regularly.

---

*It used to take as many as four workers to carry the large finished template sheets for airplane manufacture across the floor in the cool assembly department of Bell Aircraft Corp. The men set them down frequently to rest. Often edges were damaged by dragging on the floor. William H. Torbett, of the department, devised a mechanical aid. He bent the tops of two iron bars, about 3 ft. long, into grasping loops convenient for a hand grip, and the lower ends into small hooks, then mounted each bar on a pair of roller skate wheels. Now as many as 5 or 6 template sheets are handled at a time, the edges are protected and two men released for other work.*

—"The Bellringer," Bell Aircraft Corp.

---

## Welded Beads on Coal Fans

*by Raymond Septor, Jersey Central Power & Light Co.*

Here is the story of low carbon steel blades of fans used for handling pulverized coal, hard faced by welding beads on exposed surfaces, spaced ⅞ to 1½ in. between beads, depending on abrasive conditions. The fans are used to blow pulverized coal from the pulverizers to the burners of the boiler furnaces, with a part of the combustion air, generally called transport or carrier air.

Naturally, there is severe abrasion upon the blade surfaces. After the beading, the blade runs one and a half times the time period of a new un-beaded blade. The hard deposits can be rebuilt six to eight times during the life of the blade.

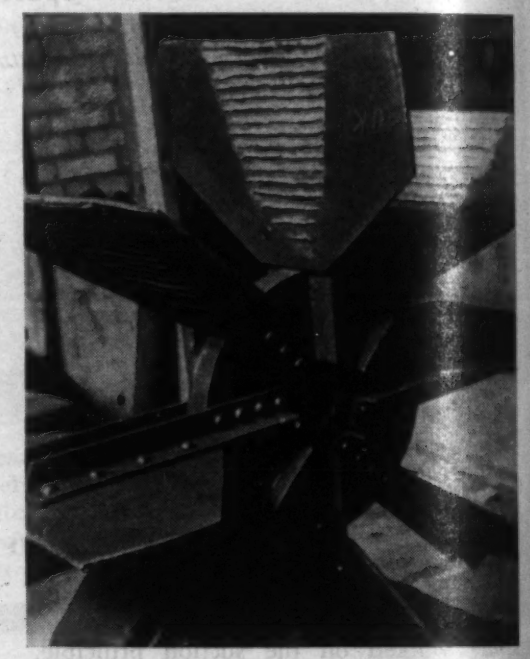
Of course, the entire blade could be given a hard welded surface. This was tried but caused so much distortion that the blade had to be discarded, not to mention the waste of deposited metal.

Experimentally, two types of electrodes have been used. The first is a high manganese-nickel-molybdenum rod, giving an austenitic, non-magnetic deposit. After six months of service, the austenite had become partly magnetic and had increased in surface hardness.

The second rod has a hard magnetic deposit that also increased in surface hardness, indicating a good portion of retained austenite as deposited, but this bead shows 20% less wear than the first.

However, in general, electrodes providing a martensitic deposit, with high initial hardness, give best results. Austenitic deposits do not surface harden sufficiently under the comparatively light impact from the coal particles.

Of course, some wear does take place between the ribs or beads, and these are filled with weld metal before the ribs are rebuilt. This causes considerable less distortion than a solid deposit.



It is true that a fan, faced with a solid deposit, did give a slightly longer run than a beaded surface, but after the second application, distortion was so severe the blades had to be replaced.

It will be noted in the accompanying photograph that the ribs are closer to one another near the blade tip than at the base because abrasive action is more severe there. This photographed blade has been welded several times.

When rewelding, the beads are lengthened and new beads added, if necessary. A thin film of coal collects in the grooves between beads and against the leading face of the beads, the film helping protect against abrasion. The fans are statically balanced after welding. Operating temperature is about 250 F.

# Metallurgical Engineering Digest

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*Blast Furnace Practice, Smelting, Direct Reduction and Electrorefining. Open-Hearth, Bessemer, Electric Furnace Melting Practice, Equipment and Refractories. Melting and Manufacture of Non-Ferrous Metals and Alloys. Soaking Pits and Other Steel-Mill and Non-Ferrous Mill Heating Furnaces. Steel and Non-Ferrous Rolling, Wire Mill, Pickling and Heavy Forging Practice.*

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# 1 Metal Production

***Blast Furnace Practice, Smelting, Direct Reduction and Electrorefining • Open-Hearth, Bessemer, Electric Furnace Melting Practice, Equipment and Refractories • Melting and Manufacture of Non Ferrous Metals and Alloys • Soaking Pits and other Steel-Mill and Non-Ferrous-Mill Heating Furnaces • Steel and Non-Ferrous Rolling, Wire Mill, Pickling and Heavy Forging Practice***

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## Retorts for Magnesium Distillation

*Condensed from "Metals Technology"*

In the Pidgeon process, briquets of dolomite and ferrosilicon are heated within metal retorts to 2150 F. under a pressure of 0.1-mm. mercury. Retorts are cylindrical castings 8 to 10 ft. long, 10 in. inside diam., with about 1 in. wall thickness, closed at one end by welding on a hemispherical dome, and on the other end by welding on a water-cooled wrought-steel chamber, in which the magnesium vapor condenses.

The process is a discontinuous one, involving 8-hr. cycles, which include 2 hr. for charging, discharging, and cleaning out. The temperature, however, is maintained steadily throughout the cycle.

A wall thickness of ⅞ in. was decided upon. Alloys tried for retorts were 35 Ni and 15% Cr, 25 Cr and 12% Ni, and 28 Cr and 20% Ni. In addition, experiments were carried on with plain steel tubing coated by welding a layer of 25 Cr and 20% Ni alloy over the surface to prevent oxidation.

None of these alloy retorts is capable of withstanding a pressure of about one atmosphere at 2150 F. All flow at a fairly rapid rate, leading to intolerable collapse of the retorts in a short time. Weight of the retort alone is sufficient to cause an impression of the piers on which it rests to show on the retort surface, which sometimes becomes serious enough to cause failure.

It was decided to adopt an alloy containing 28 Cr and 15% Ni, as this is adequate in resistance to the oxidizing conditions at 2150 F.

Increased life is possible only by resorting to mechanical means, such as increasing the wall thickness, using reinforcements, and, most effectively, by expanding each time excessive collapse occurs. Increasing the wall thickness from ⅞ in. to 1⅛ in. lengthened the life prior to collapse from an average of 60 days to an average of 95 days.

Collapsed retorts can be reclaimed by blowing them out virtually to shape by means of 90 lbs. air pressure, introduced into the retort while sealed and at operating temperature, for two or more hrs. Two retorts had their lives extended to a year by repeated expansions. At one plant, average complete life was 159 days for retorts with walls ⅞ in. thick and 138 days for those with walls 1⅛ in. thick.

The intiial increase in life obtained by increasing wall thickness from ⅞ to 1⅛ in. is gradually overcome by successive expansion of the collapsed retorts, so that the extra metal thickness is of no practical advantage in seeking an ultimate life of more than about 230 days.

The increase in initial life due to greater wall thickness is probably not commensurate with increase in cost of the retort. Retorts are expensive enough to warrant careful consideration of all possibilities of repair before scrapping.

The high-chromium alloys have higher average total life than the high-nickel alloy. A somewhat longer average life appears to result from static casting of 1⅛ in. wall retorts than from centrifugal casting.

—Francis B. Foley & Robert L. Sebastian. *Metals Tech.*, Vol. 11, Feb. 1944, T. P. No. 1709, 5 pp.

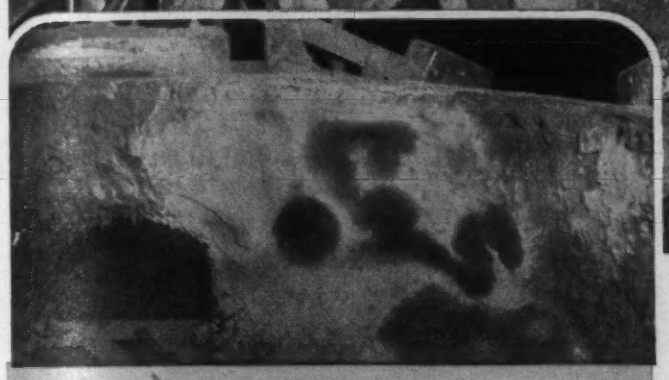
## Blast Furnace Sintering of Ores

*Condensed from "Stahl und Eisen"*

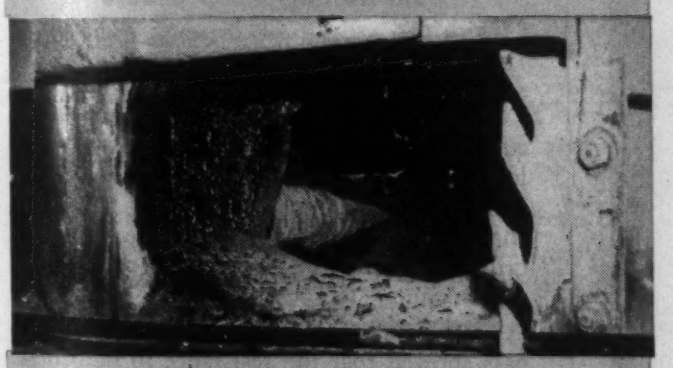
To be suitable for the blast furnace, sintered ores must possess definite qualities; the sinter must be lumpy, contain few pieces below 8 mm. (⅓ in.), have a certain strength, and be as porous as possible to be easily reduced in the blast furnace. All conditions for an economical operation with sintered ore were carefully investigated.

From the chemical point of view, at first a reduction takes place in the sintering process, then, after the highest temperature has been passed, an oxidation. The reduction lowers the temperature of fritting, and probably also of the plastic state, but surely the melting point.

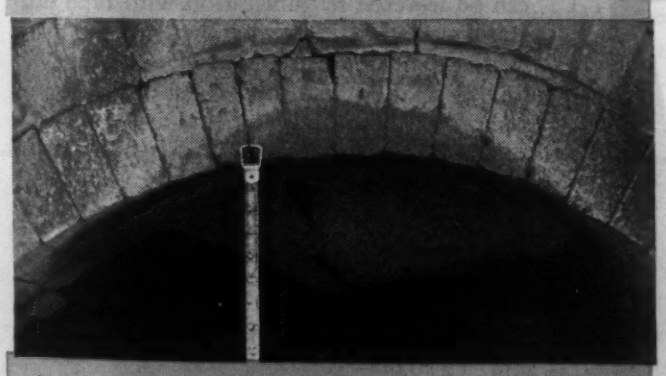
The range of melting of the ores is lowered so much by reduction that the mixture becomes liquid and very fluid at about 1100 to 1300 C. (2000 to 2370 F.).



Above—Dark areas at right of door are Gunmix repairs, applied to hot sidewall of small electric furnace.



Above—Conical knob of Gunmix—5" x 14"—stuck to electric furnace sidewall to left of work door, to demonstrate hot cohesive and adhesive nature of Gunmix. Temperature 1600° F.



Above—200 lbs. of Gunmix shot vertically on under side of brick kiln arch at 50° F., to demonstrate cold-wet adhesive properties.

# For rapid repair of hot walls by air stream and water

Gunmix creates great interest wherever it is demonstrated. In service, it is proving its practical value as an effective easy-to-apply maintenance refractory for hot basic furnace walls.

Now, tested by many months' regular use in more than a score of basic electric steel furnaces, this unique refractory is proven to have these valuable properties:

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4. Application is extremely simple, through a small, easy-to-handle air-gun, in which the prepared refractory is automatically mixed with water.

Gunmix guns are now available. Your suggestions for further possible applications of this versatile new-type refractory are welcomed.

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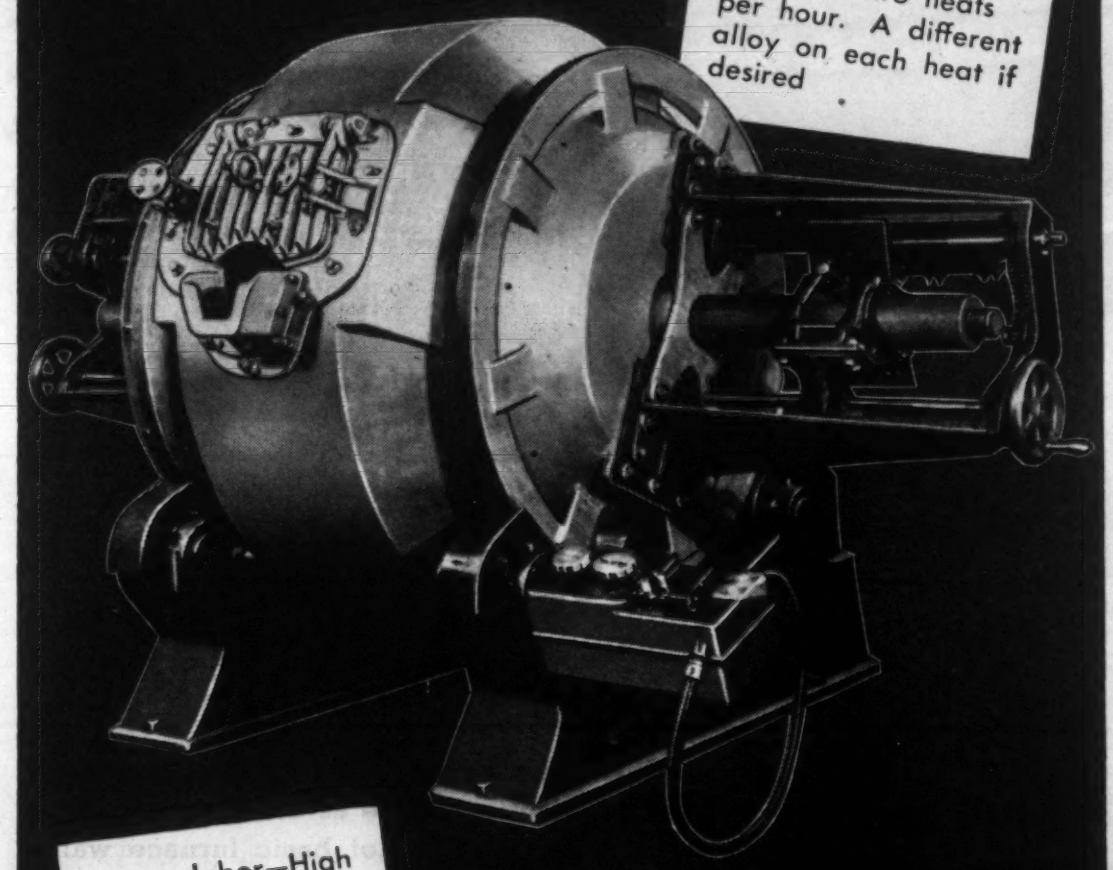

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The ore particles collect in drops, spacious pores are formed as in a natural sponge. The air can pass through easily so that combustion is promoted.

If, however, this process would go on, more and more of the melting mass would collapse and form a dense layer impassable for air. This would stop admission of air and sintering would not continue (as actually happens in practice).

In the transition from reduction to oxidation, the melting point of the walls of the sinter sponge rises again, the range of viscosity increases to above 1450 C. (2640 F.), which solidifies the walls of the sinter sponge. The solidification is furthered by air cooling.

The carbon content of the mixture should, therefore, be made so that the heat requirement for melting, liquefaction and reduction energy is satisfied but that the reduction is not carried too far, so that the oxidation necessary for solidification is not delayed. Too much and too little cause operating troubles. Each ore mixture has, therefore, an optimum of fuel content.

The sinter process can be represented by the following schema: Chemically—removal of water and carbon dioxide; dissociation of oxygen from haeuratite; reduction, oxidation. Physically—removal of water and carbon dioxide; fritting—shifting of the mass, shrinking, baking and conglomeration, recrystallization, plastic state; melting—viscous state, fluid state; solidification.

—F. Hartmann, *Stahl u. Eisen*, Vol. 63, May 20, 1943, pp. 393-398.

## Cold-Rolling Strip Steels

*Condensed from "Mitt. Kaiser-Wilhelm-Inst., Eisenforsch. Düsseldorf"*

The increase of mechanical strength by cold-rolling was investigated in four austenitic steels: One chromium-nickel, two chromium-manganese, and one nitrided chromium-manganese steel, in one patented carbon and in one low-alloy chromium-molybdenum steel.

Tests with increasing reduction in one pass showed that the resistance to deformation, which increases especially steeply with higher reductions in austenitic steels, can be lowered by lubrication with rape oil, and amounts to less for these steels than in the patented carbon steel. Resistance to deformation increases with falling temperature at both high and low temperatures.

The highest values of tensile strength could be reached in many small passes for a chromium-nickel or chromium-manganese steel, namely 160 kg. per sq. mm. (228,000 p.s.i.), while another chromium-manganese and the nitrided chromium-manganese steel reached even 190 kg. per sq. mm. (270,000 p.s.i.).

Deformation in few, larger reductions produced lower tensile strength. The carbon and the low-alloy steel gave by cold-rolling only 150 and 125 kg. per sq. mm. (213,000 and 178,000 p.s.i.), respectively.

The specific saturation magnetization shows a maximum with increasing reduc-

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# Taylor ZIRCON HEARTHS

## produce cleaner metal

## increase production

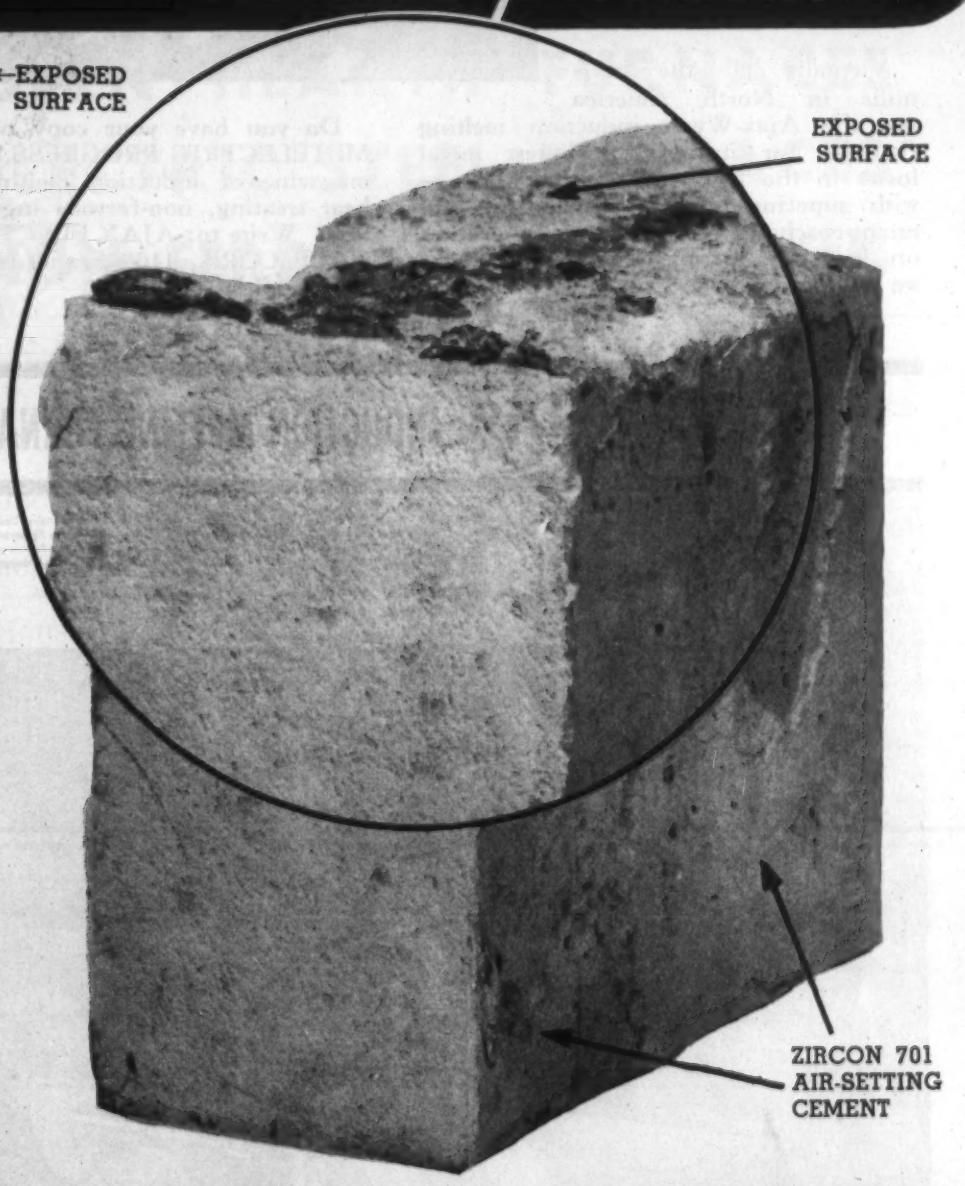
←EXPOSED SURFACE

### ORDINARY FIRE BRICK AFTER SERVICE

Depth of metamorphosed area is clearly shown by the color change. Observe how the original structure has been altered by penetration of aluminum and thermit reaction with iron oxide and silica brick.

### TAYLOR ZIRCON AFTER SERVICE →

Section thru TAYLOR ZIRCON BRICK removed from hearth of aluminum re-melt furnace. 14,750,000 lbs. melted on this hearth. No penetration.




We think that these illustrations prove conclusively that, if the Refractory Industry ever developed a product which is unequalled, even uniquely fitted for one particular job, TAYLOR ZIRCON is certainly that product, when used for hearth construction in reverberatory type furnace for melting Aluminum.

Properties of TAYLOR ZIRCON REFRACTORIES and other pertinent data are given in Bulletin No. 200. Write for your copy today.

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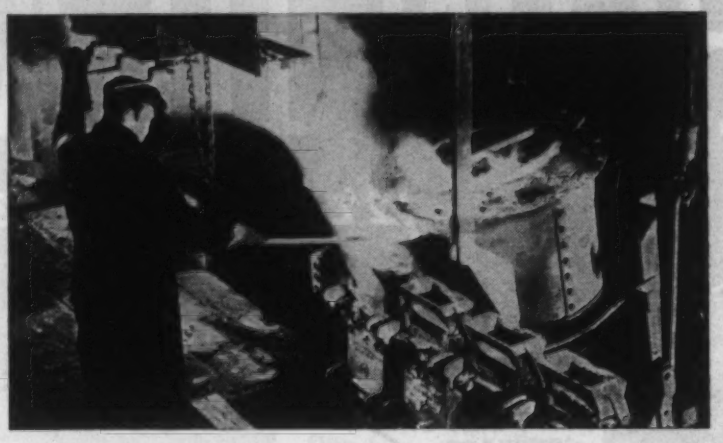
No industry melting *commensurate tonnage** of vital metal can quite match the brass mills for conservation and low melting losses. The savings of metal total millions of pounds; clearly the method they use is worth noting:



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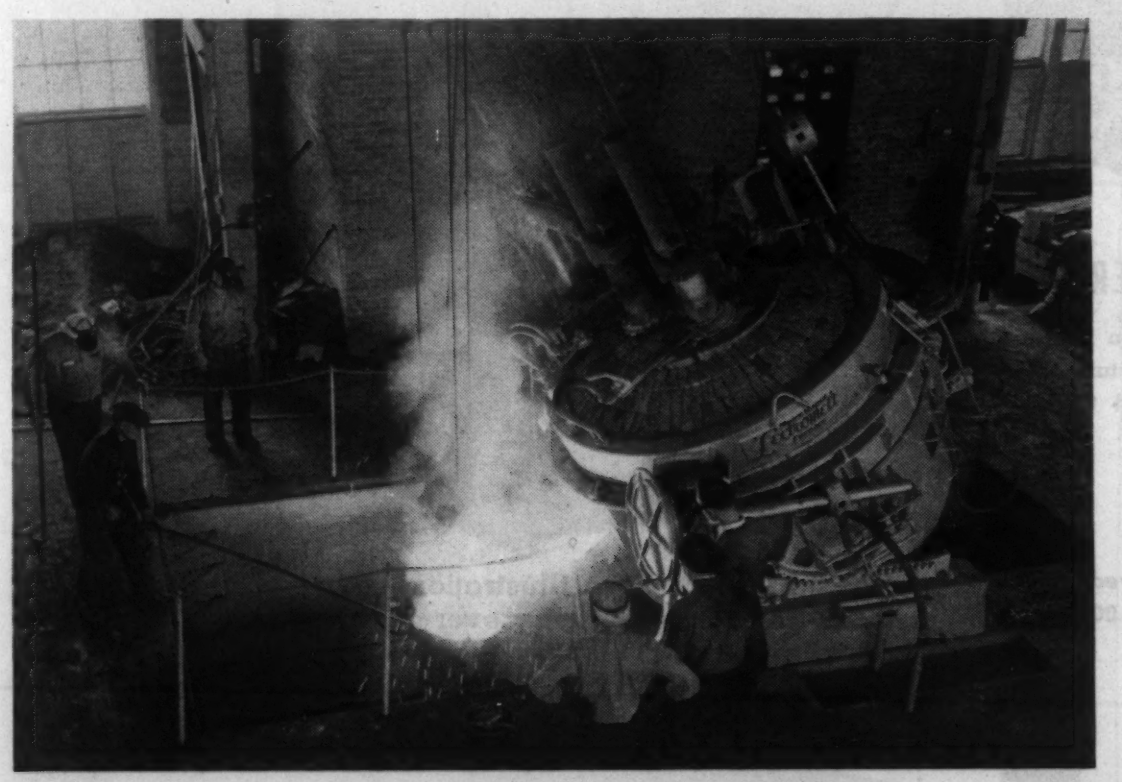


MOORE RAPID *Lectromelt* FURNACES

**For the efficient melting of plain carbon and alloy steels for ingots, and castings, and gray and malleable irons.**

PITTSBURGH LECTROMELT FURNACE CORPORATION
PITTSBURGH, PENNSYLVANIA


tion in one pass, while in several passes the saturation increases continually, and the increase is the steeper the greater the number of passes for the same total reduction.

The magnetic transformation is largely dependent on the temperature at the beginning of cold-rolling, and a rolling process was found which, at 200 C. (390 F.), starting temperature with preheated rolls, produced no such magnetic transformation as has been observed in the nitrided alloy steel at room temperature. The tensile strength of the strip was, however, lower in this process than by starting at room temperature.

An examination of the intercrystalline corrosion did not establish any relation between the resistance against this corrosion and the phase condition as determined by magnetic saturation. The tendency to intercrystalline corrosion decreases with increasing deformation.

—A. Pomp & W. Puzicha. *Mitt. Kaiser-Wilhelm-Inst., Eisenforsch. Düsseldorf*, No. 26, No. 2, 1943, pp. 13-36.

## Electric Furnace Practice

*Condensed from "Blast Furnace and Steel Plant"*

In 1943 there were about 236 electric furnaces engaged in steel ingot production, with a yearly capacity of over 6,000,000 tons; furthermore, there were about 500 furnaces in casting production with a capacity of 3,000,000 tons.

Contrary to earlier belief, the product from the larger furnaces, of over 25 tons capacity, is as good or better than from the smaller. The modern power transformer with efficient switchgear is the main reason for the success of the larger furnace.

Successful graphite electrodes permitted transmission of the necessary energy. Improved refractories, furnace design and metallurgical testing were factors.

Since it is necessary that sulphur and phosphorus be removed, the basic practice, rather than acid, is almost universally used. In melting the more complex types of alloy steel, the cold charge is the preferred method to conserve critical alloys. It also permits selection of a wide variety of chemical analysis ranges in the metal mix.

The electric charge is 100% scrap as against 40% for the open hearth; hence, more care must be taken in the selection of scrap for the electric. Because of improved methods of producing open hearth steel, the electric furnace is meeting with more competition from that process.

Accordingly, electric steel must be regarded as a quality product rather than quantitative. The flexibility of the electric process provides cleaner and more uniform steels, with lower rejections, and closer conformity to desired chemical analysis.

### Furnace Bottoms

The first requisite to good steel is a good bottom. Rammed bottoms of suitable

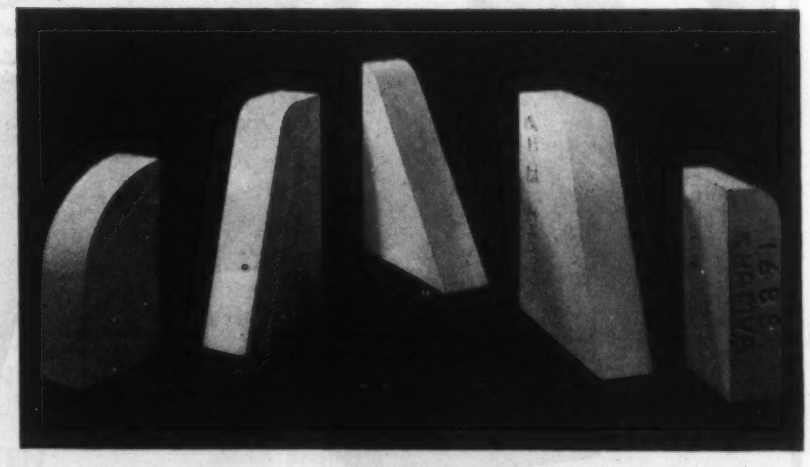
"Shamva" Mullite has proven its ability to give

*Increased Production*

IN

OPEN HEARTH FURNACES
ELECTRIC STEEL FURNACES
NON-FERROUS, GREY IRON
AND STEEL FOUNDRIES

The adoption of "Shamva" Mullite brick for open hearth furnace construction was one of the news highlights of the Pittsburgh meeting. Various initial installations have proved most satisfactory, as has been the experience in electric steel manufacture and all types of foundry melting.



Illustrating a few of the "Shamva" Mullite special jamb brick which are giving such exceptionally long service life.

MAXIMUM REFRACTORY LIFE
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**Distinctive Features of "SHAMVA" MULLITE:**

- High softening and fusing point: fuses at 3335° F.
- Minimum expansion and contraction
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- Resistance to slag and abrasion.

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BEADING and GROOVING MACHINE

For precision beading, grooving and form rolling tubes through use of rolling mill principle. Grooves are developed by pressures accelerated rapidly by cam action on a form roll. Inside diameters at grooved section controlled by form roll. Hand controlled "draw-in chuck" provided for quick and simple loading.

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material are more efficient than burned-in bottoms. In ramming, care must be taken that the sub-hearth be properly constructed, shaping the hearth with the brickwork before ramming is started.

Rammed material need not be over 6 in. thick in the 10-ton furnace to 10 in. for 60- and 100-ton furnaces. After ramming, it should be brought to 2900 F. before preparing a charge.

A well set-up bottom will last two to three years, but one must be generous about renewing them, as they take much punishment from absorbed metal, slag, silica and alloys. Silica brick roofs are the most practical for large furnaces, being lighter and having greater structural strength at high temperatures.

Metal encased magnesite brick have generally been adopted for linings, it being advisable to imbed sufficient heavy-wall water-cooled piping in, the hottest areas at a safe distance above the slag line. About 275 heats per lining is good for the larger furnaces, and 450 to 550 for the smaller.

Types of steel produced in this furnace today range from single slag, ladle deoxidized structural steels to high-speed tool steels, stainless, supercharger steel and specialties. Most of the tonnage is required for aircraft, bearings and ordnance.

Most of the engineering grade steels are made by the two-slag process. The first slag is formed during the melting and oxidizing period, and is removed from the furnace; the second, by adding proper amounts of lime, sand, fluorspar and fine crushed coke, the fluxing of which produces the reducing agent, calcium carbide, which is deoxidizing in effect.

—Harry F. Walther. *Blast Furnace & Steel Plant*, Vol. 32, Mar. 1944, pp. 334-342.

## Pitch as an Open Hearth Fuel

*Condensed from "Iron and Steel Engineer"*

In April, 1934, the use of a small amount of liquid pitch as fuel in the open-hearth furnaces was started at Bethlehem Steel Co. at Johnstown, Pa. Today about 30% of the open-hearth fuel is pitch, which has advantages over oil. It is just as good if not a better fuel than oil, and many first helpers prefer pitch, which is a by-product of the coke plant.

Pitch is a composite of numerous complex chemical compounds, the relative gravities of which change as the coal-tar and distilling temperatures vary. The simplest definition would be: "The residue after certain tar-acids have been distilled off."

It will vary in analysis from plant to plant. The limit for the melting point of pitch to be used as a liquid fuel is taken as 120 F.

The pitch received from either one of two plants is stored in two 13,400 gal. insulated storage tanks at the open-hearth department. The temperature in these tanks is maintained at 280 to 300 F. by steam coils.

The pitch is removed from either one of the open-hearth storage tanks by two 5 in.

# SM FERROCHROME . . .
## *for Ladle Additions*

SM Ferrochrome is a specially developed alloy for use in making ladle additions of chromium to steel. It goes into solution more readily than other grades of ferrochrome and thus helps to assure even distribution of the chromium. With this improved alloy, larger additions of chromium can be satisfactorily made in less time. Also, SM Ferrochrome yields higher recoveries of chromium. Less of this alloy needs to be added to produce a desired effect.

One of our metallurgists will call at your request to tell you more about SM Ferrochrome and give you practical help in its use. He can tell you also about many other Electromet ferro-alloys that help improve the quality of steel and increase the speed with which it can be made. This service is backed by more than 37 years' experience in the production and use of quality ferro-alloys, and is available without obligation.

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Low-Carbon Ferrochrome (in grades, maximum 0.06% to maximum 2.00% carbon)
High-Carbon Ferrochrome
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Chromium Metal
Chromium-Copper
CMSZ Alloy
Miscellaneous Chromium Alloys

**CALCIUM**
Calcium-Silicon
Calcium-Manganese-Silicon
Calcium Metal

**COLUMBIUM**
Ferrocolumbium

**MANGANESE**
Standard Ferromanganese 78 to 82%
Low-Carbon Ferromanganese
Medium-Carbon Ferromanganese
Manganese Metal
Miscellaneous Manganese Alloys

**SILICO-MANGANESE**

**TUNGSTEN**
Ferrotungsten
Tungsten Powder

**BORON**
Ferroboron
Manganese-Boron
SILVAZ Alloy 3
SILCAZ Alloy 3

**SILICON**
Ferrosilicon 50%
Ferrosilicon 75%
Ferrosilicon 80 to 90%
Ferrosilicon 90 to 95%
Silicon Metal
SMZ Alloy
Miscellaneous Silicon Alloys

**VANADIUM**
All grades

**EM BRIQUETS**
Silicon Briquets
Silicomanganese Briquets
Ferromanganese Briquets
Chromium Briquets

**ZIRCONIUM**
Zirconium 12 to 15%
Zirconium 35 to 40%

*Information about these and miscellaneous alloys and metals produced by Electromet is contained in the booklet "Electromet Products and Service." Write for a copy.

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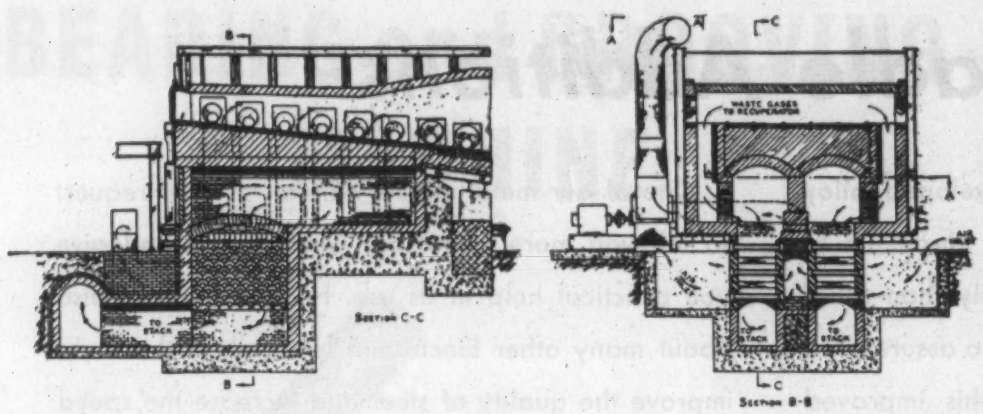
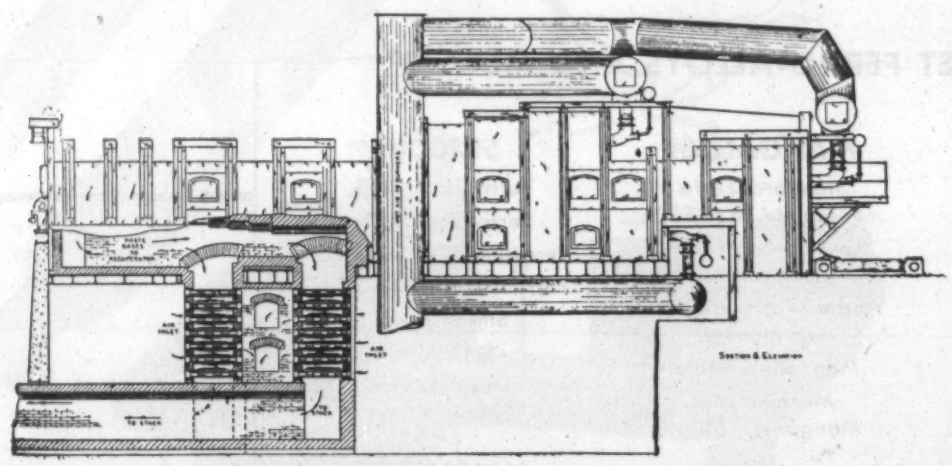


**One of five continuous billet heating furnaces in a seamless pipe mill equipped with a "Fitch" recuperator. Fuel savings up to 30% are obtained with the recuperator.**



**One of the two continuous slab heating furnaces in a strip mill equipped with a "Fitch" recuperator. Each furnace has a maximum capacity of 80 tons per hour.**

**Other successful installations include the conversion of regenerative batch type slab heating furnaces to recuperative furnaces resulting in a greatly increased capacity.**

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**FITCH RECUPERATOR CO.**

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by 6 in. triplex, vertical plunger type, motor driven pumps, each with a capacity of 42 gal. per min. at 130 lb. pressure. Generally, the pitch can be pumped by one unit with the other serving as a spare.

It is not practical to have a simpel pitch line to the open-hearth, due to possible freezing in the line. There is a "loop" system of pitch lines throughout the open-hearth. The pitch is pumped from the tanks through the entire open-hearth in a 4-in. supply line. The excess is returned to the storage tanks by a 3-in. return line. Each open-hearth takes its pitch from one of these lines.

### Heating Tanks Required

Pitch reaching the individual open-hearth furnaces is cooler than it was at the pumps and, therefore, 50-gal. heating tanks have been installed on each furnace. The pitch comes from the main supply line into the heating tank, then to the control panel and into the burners.

The original tanks contained brass heating coils, but because of rapid corrosion it was necessary to change to steel coils, which have to be renewed every 3 to 5 yr.

From the small heating tank the pitch passes through a hand operated valve that controls the ratio of flow, then through two area-type meter bodies in series and thence to the burners. The first meter indicates and records on a chart the amount of pitch being used while the second sends an electrical impulse to the fuel ratio control regulator.

The bronze plunger originally used in the meter bodies proved unsuccessful because of corrosion. Later the manufacturer furnished stainless steel plungers, which have been found satisfactory. They are cleaned and recalibrated at the end of each furnace campaign.

Experience indicates that 1,200,000 gal. of bunker "C" oil is saved monthly by using pitch and a corresponding saving in transporting this quantity of liquid fuel is made since the pitch is not handled by the main railroads.

The burning of pitch is, in general, easy after the proper system of controls, as herein described, have been installed. The flame temperature may be a little higher than that of oil and the net tonnage per hour seems to be slightly higher with the use of pitch, but the heat equivalent per ton is also higher.

The deposits in the checkers appear to be of a different analysis from those produced by oil. The amount of the deposit seems to be greater on a pitch-fired furnace.

—J. F. Wilbur. *Iron & Steel Engr.*, Vol. 21, Mar. 1944, pp. 65-71.

## Pouring Times for Alloy Steels

*Condensed from "Stahl und Eisen"*

The improvements made in the Ruff pouring test for determining the mechanical properties of steel from these samples, since its first application in 1936, go under three headings: Simplification of the pouring form; introduction of uniform drying of the

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forms in the furnace at 180 C. (356 F.) in place of the unsatisfactory drying in air; and by pouring of two forms one after the other, of which that having the greatest length is considered as determining for the rating of the melt.

Pouring samples of about 400 melts over seven months time from a basic 20-ton arc furnace and some open-hearth furnace melts for chromium-molybdenum steels with and without nickel are evaluated and used as a basis for directions in the application of the test in routine operation.

The samples proved to be a good means for determining whether a melt needed a subsequent heating. It was further established that a lower liquidity of the melts investigated was connected with a noticeable reduction in notch-impact toughness and reduction of area.

An investigation of the effect of nickel showed it promotes liquidity, and the different liquidity of nickel-bearing and nickel-free steels at the same overheating of the melt was especially noticed. These pouring samples can also be used for the basic open-hearth furnace after a preceding deoxidation with aluminum wire.

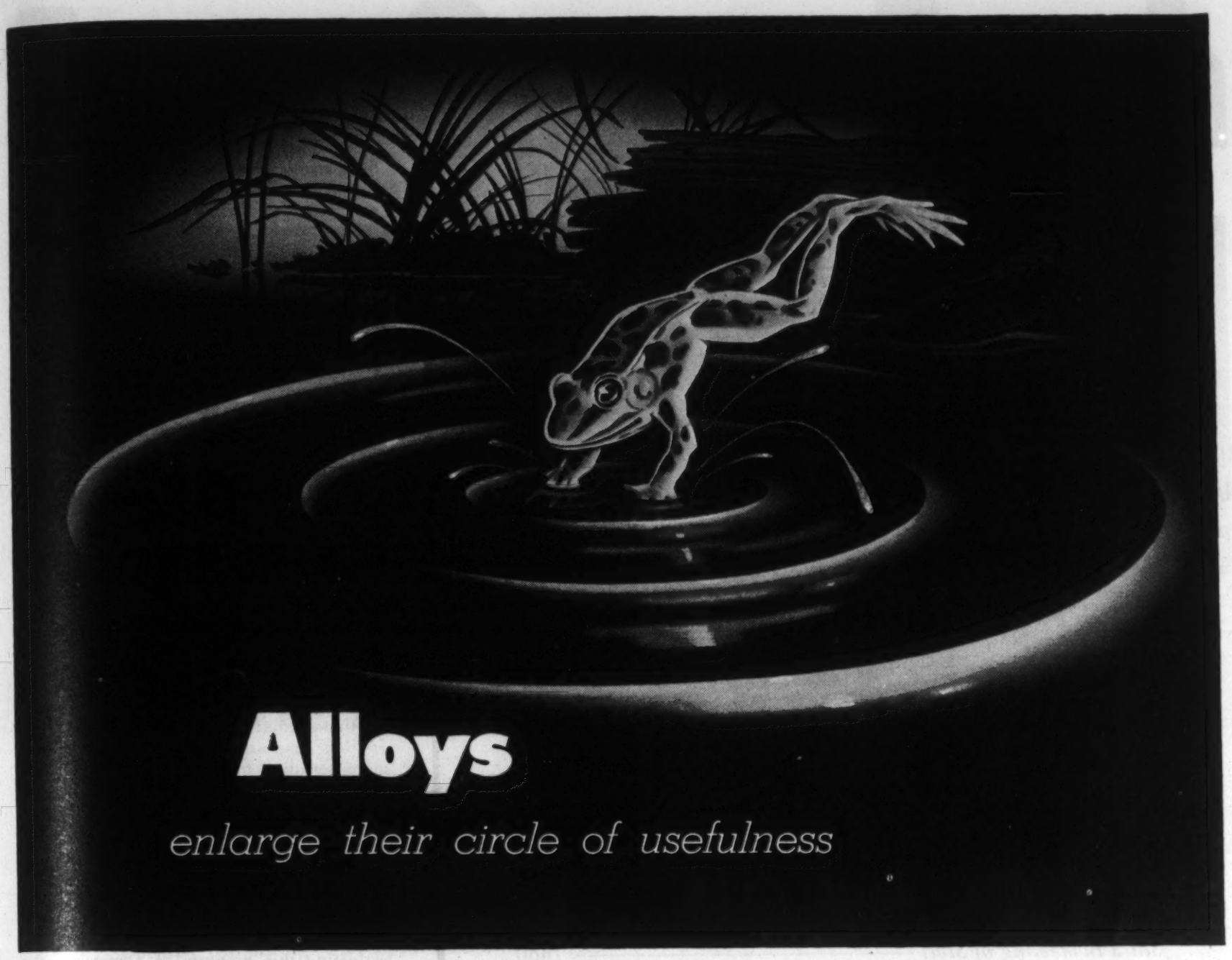
The time interval before the chromium addition was especially important in the pouring of the samples of chromium-alloy steels melted in the basic open-hearth furnace. The following table gives a comparison of nickel-bearing and nickel-free alloy steels from both basic open-hearth and basic arc furnaces at a minimum strength of 150,000 psi.

| *Designation* | *Open-hearth furnace Cr-Ni-Mo steels* | *Arc Furnace* | |
|---|---|---|---|
| | | *Cr-Ni-Mo steels* | *Cr-Mo steels* |
| No. of melts | 8 | 11 | 14 |
| No. of samples | 50 | 50 | 50 |
| tapping temperature, F. | 3009 | 3013 | 3054 |
| pouring temperature, F. | 2813 | 2838 | 2887 |
| increase of pouring temperature, F. | —— | 25 | 49 |
| % C | 0.42 | 0.38 | 0.40 |
| % Cr | 2.21 | 2.22 | 2.77 |
| % Ni | 2.88 | 2.74 | 0.38 |
| % Mo | 0.57 | 0.46 | 0.42 |
| elastic limit, psi. | 137,500 | 136,200 | 137,800 |
| tensile strength, psi. | 159,600 | 157,900 | 159,300 |
| elongation, % | 14.8 | 15.9 | 15.9 |
| reduction of area, % | 41.7 | 48.4 | 51.1 |
| notch-impact toughness, mkg./cm². | 6.8 | 8.1 | 9.5 |

In the discussion, the point is brought out that, from a statistical evaluation, the liquidity of structural steels increases in the following order: (1) Cr-V and Cr-Ni-Mo steel; (2) Mn steel (1.5 Mn, 0.3% C); and (3) steel with 1% Ni and unalloyed steel (0.35 to 0.45% C).

The better the liquidity of a steel the longer are the pouring times needed for a faultless product.

—W. Ruff. *Stahl u. Eisen*, Vol. 63, June 3, 1943, pp. 438-443.



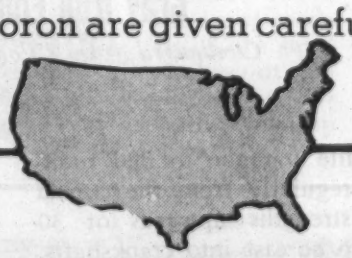

Increase of available supplies, as in the case of Tungsten, improved economy of use, as in the case of Molybdenum, and newly discovered metallurgical potencies, as in the case of Boron, point clearly to larger, more varied employment of alloy steels and irons in the months just ahead.

Alloying for one purpose or another will undoubtedly be hastened by the competition of non-ferrous metals and other materials.

One noteworthy development is the growing use of Molybdenum in structural steels, justified by the high degree of improvement obtained from very minute additions of the alloying element.

The Molybdenum Corporation has been unsparing in its effort to keep abreast of such advances, both as a source of metallurgical advice and as a supplier of alloying materials.

Inquiries on any use of Molybdenum, Tungsten, or Boron are given careful attention.



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# 2 Foundry Practice

*Melting and Pouring of Gray Iron, Malleable, Steel, Brass and Bronze, Aluminum and Magnesium Castings • Molding, Core-Making, Gating and Risering, etc. • Foundry Furnaces, Refractories, Ovens, Molds, Sands, Binders, Auxiliary Equipment and Materials*

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## Gray Iron Foundry Control

*Condensed from "Foundry Trade Journal"*

Today it is quite common to find foundries producing regularly from the cupola cast iron with strengths upwards of 30 tons per sq. in. to be cast into crankshafts, blanking and forging dies and machine tool members.

In addition to the saving in material cost, it gives extremely satisfactory die operation by reason of the dense graphite bearing nature of this iron. Graphite here prevents or minimizes galling, which is one of the worst enemies of the die-maker, and a smooth long life surface is attained during operation of the die.

It has been claimed by one manufacturer that this iron with a cast strength of 27 tons per sq. in. compares favorably with a 40-ton steel under actual working conditions as a crankshaft. The explanation is partly tied up in a property of cast iron called "crackless plasticity."

Generally speaking, the "E" value increases in cast iron as the tensile strength increases, and it has now been established that high-duty iron possesses true elastic properties, and, as a material of construction, is comparable to steel castings and forgings.

It has been found that iron with high tensile strength possesses a yield point relatively higher than that of cast steel, so that, whereas in the case of steel, plastic deformation commences at 40 to 50% of the tensile strength, high duty iron is free from permanent set-up to about 80% of its tensile strength.

It is common practice to facilitate the breakage of a brittle material, such as glass, by means of scratching the surface. This "notch sensitivity" is exhibited by many materials, and is particularly noticeable in some steel parts where notches are provided by oil channels, keyways, sharp fillets, screw threads, tool marks, etc.

Many soft and ductile steels have failed in service in a brittle manner owing to the weakening influence of a notch.

### Graphite Reduces Notch Sensitivity

Gray cast iron, possessing as it does an infinitely large number of small notches in the form of graphite flakes, is far less affected by additional notches in the form of keyways, etc., than is steel, which may have its endurance halved by the presence of such a notch.

It is apparent that the function of graphite here is to dissipate stress throughout the casting, thereby preventing local concentrations of stress from starting small cracks, which would later lead to fracture by fatigue. In recent literature this property of a material to withstand sudden overstress without fracturing has been called "crackless plasticity."

High-strength irons containing, as they do, less graphite might be expected to be more sensitive to the presence of notches than irons of lower strength, and, in practice, this has been found to be the case.

Owing to its graphite content, gray iron possesses excellent damping properties much superior to those of steel—one good reason why machine tool builders use this material wherever possible.

Possibly the most effective apparatus for evaluating this property of a metal is the Foeppl-Perts machine, in which a round test bar is set in torsional vibration, its free vibration being recorded on a moving chart until it becomes stationary, when all energy has been dissipated. The width of the recorded vibration is then measured and the damping capacity calculated.

—Brian Russell. *Foundry Trade J.*, Vol. 72, Jan. 6, 1944, pp. 3-8, 2.

## Copper Alloy Castings

*Condensed from "The Iron Age"*

With the rapid development of copper alloys, the foundryman will find that he can offer castings from these recent developments for industrial use that were not possible a few years ago. They require some additional skill and care in handling.

First, it is essential that gates and ingots be melted down rapidly under proper conditions of combustion. The furnace should be constructed so that the linings radiate the highest possible amount of heat in the shortest time. Up-to-date furnaces with the right blower setup and combustion controls are maintaining furnace temperatures close to 3000 F.

Back pressure should be avoided if the metal is to lie quietly in the crucible. Plenty of 16-oz. air should be supplied. With

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Because the sailing of a ship, for example, might be held up because a contractor had to wait for a casting like the one in the illustration. With Truline, foundry men find jobs run smooth—and faster. First, you save time in making the cores themselves. Then you save in baking and clean-up.

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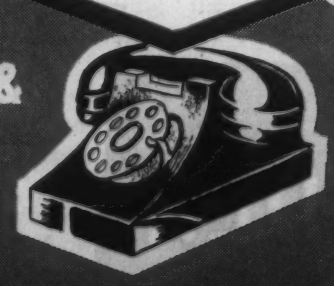

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sufficient air of suitable pressure being delivered from the blower, the amount of gas or oil injected into the combustion line can be increased over the amount of fuel that a lower pressure blower will deliver. Roughly, there should be 10 to 11 parts of blower air to one part of fuel, to create a neutral or slightly oxidizing flame.

With an overdose of gas or oil, in combustion, the unburned portion will be absorbed into copper base alloys during the breakdown period that metal has to go through before it is molten. After the charge is molten, additional fuel can be put into combustion chamber with greater safety. Automatic control is the best solution for this problem.

Sand that is weak or too fine will cause pores. To be right it must have a permeability of 25, green strength of 7, grain size 100, and clay content 10% when moisture is 6%. Actually, sand should be ordered to specifications.

The proper test bar should be selected; the pouring temperature of the test bar must be closely followed, and the bar must then be shaken out of the sand at a definite time after casting.

Another factor that enters into the melting procedure is flaring. This flaring is a deoxidizing action. A recommended procedure is: (1) Melt in a clean crucible, or in one previously used for manganese; (2) bring the metal quickly to 1950 F. and flash strongly; (3) use a good flux or charcoal, or glass as cover; (4) combustion to be neutral; (5) stir thoroughly; (6) flare zinc for 1 min.; (7) add 1 to 1½% electrolytic zinc for weight of gates or risers; none should be added for ingot; and (8) skim thoroughly and pour evenly to avoid splashes.

For pouring a test bar: (a) Skin dry the mold; (b) pour at temperature for good physical properties; (c) shake out after 45 min. to avoid brittleness; (d) avoid heavy cuts when machining, and do not allow metal to become too hot; (e) if feeder or riser does not show shrinkage on top section, the bar should be discarded; (f) one bar should be broken in vise before machining; if yellow spots are visible, bar was not fed properly and shrink areas are present that lower physical properties.

—H. R. McGowan. *Iron Age*, Vol. 153, Mar. 2, 1944, pp. 50-52.

## Silica Blanketing of Steel

*Condensed from "Archiv Eisenhüttenwesen"*

Experiments on silicon reduction in steel casting lead to the important conclusion that the use of sand for covering the melt is preferable to a liquid glass slag. The reduction of silica proceeds much quicker under the sand cover, while the oxygen content does not go higher than under the glass slag; the sand layer protects from oxidation by air oxygen as well as the glass slag.

The most advantageous operating temperature is about 1650 C. (3000 F.) for obtaining quick silicon reduction. Temperatures over 1700 C. (3100 F.) did not show

## A FEW FACTS ABOUT CORHART PRODUCTS

Corhart Electrocast Refractories are high-duty products manufactured by melting selected and controlled refractory batches in electric furnaces, and casting the molten material into molds. After careful annealing, the finished shapes are ready for shipment. Dense, high-melting refractories, they are especially designed for resistance to corrosive action.

### PRODUCTS

CORHART STANDARD ELECTROCAST is a high-aluminous refractory.

CORHART ZED ELECTROCAST is Zirconia-bearing.

CORHART ELECTROPLAST is a high-temperature plastic refractory made from Standard Electrocast which has been ground and crushed. Especially designed for ramming. Furnished dry.

CORHART MORTAR is a high-quality cement for laying up Electrocast, clay brick, or any aluminous refractory.

### CHARACTERISTICS OF STANDARD ELECTROCAST

POROSITY: Less than 0.5%—therefore virtually no absorption.

FUSION POINT: Cone 38 without any appreciable softening below that point.

HARDNESS: 8, Mineralogist's scale.

SPECIFIC GRAVITY: Blocks weigh approximately 183 lbs. per cu. ft.

COEFFICIENT OF EXPANSION: 0.000006 between room temperature and 900° C.

SPECIFIC HEAT: 0.25 cal. per gm. per °C. at 980° C.

THERMAL CONDUCTIVITY: 25 BTU per sq. ft. per hour for gradient of 1°F. per inch.

COMPOSITION: Standard Electrocast is of an aluminous crystalline nature.

CORROSION: Because of low porosity and inherent chemical make-up, Corhart products are highly resistant to corrosive action.

### APPLICATIONS

Most heat processes present spots where a better refractory material is needed in order to provide a balanced unit and reduce the expense of repeated repairs. It is for such places of severe service that we invite inquiries regarding Corhart Products as the fortifying agents to provide the refractory "balance" desired.

The following is a partial list of applications for which Corhart Products are suggested:

ELECTROLYTIC CELLS — for production of Magnesium and other light metals.

SILICATE OF SODA FURNACES — sidewalls, bottoms, and breastwalls.

HEARTHS AND SMELTERS — for non-ferrous metals.

ALKALI AND BORAX MELTING FURNACES — fast-eroding portions.

GLASS FURNACES — the entire installation of flux walls and bottoms, breastwalls, ports, tuck-stones, forehearths, recuperators, etc.

RECUPERATORS—tile, headers, separators, etc.

ENAMEL FRIT FURNACES — flux walls and bottom.

BRASS FURNACES — metal contact lining.

ELECTRIC FURNACES — linings for rocking type, and rammed linings of Electroplast for this and other types.

BOILERS — clinker line.

### STOCK SHAPES AND SPECIALS

Standard and Zed Electrocast are made in stock shapes and in many special shapes. The weight of individual pieces may run to 3500 pounds.

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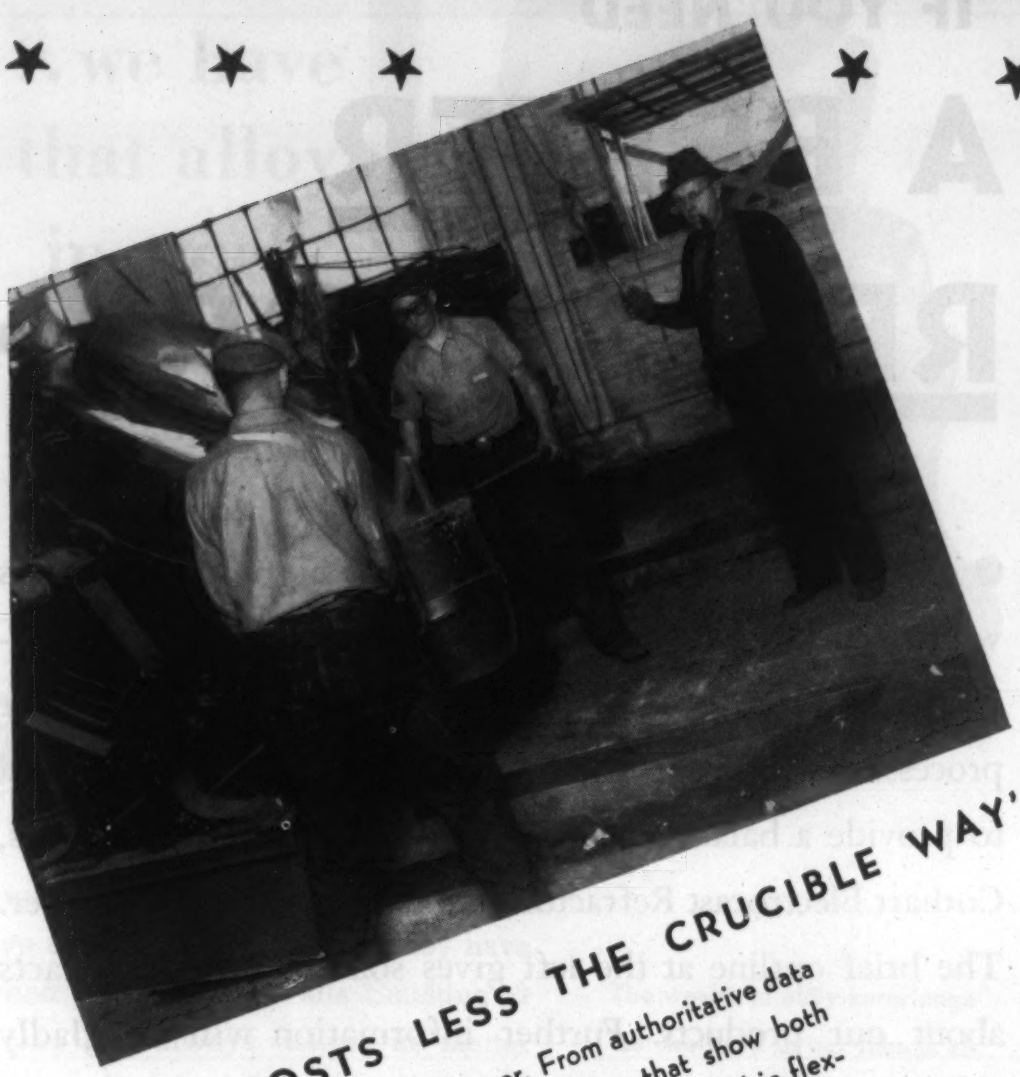

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greater reduction velocity, and rather impair the life of the ladles and crucibles.

In order to produce soft steels on a lining of silica, the carbon in the charge should prevent over-oxidation of the steel, so that after practically completed silicon reduction the silicon content required for killing has been obtained. Steels produced in this manner show a slight tendency to age.

Although these results were obtained in a coreless induction furnace, it seems possible to replace the slag entirely or partly by sand also in other furnaces, *e.g.*, the open hearth. A quicker silicon reduction is obtained, and, furthermore, the danger of a renewed oxidation by the slag is eliminated.

—W. Geller. *Arch. Eisenhüttenw.*, Vol. 15, May 1942, pp. 479-490.

## Oil-Sand Foundry Practice

*Condensed from "Foundry Trade Journal"*

The extent to which fineness of grain size increases area is not generally realized. In Aptaker's paper "Core Making" (A.F.A. Transactions) the relation of grain size to surface area is demonstrated.

For example, 1 cm. cube reduced to small cubes of 0.1 mm. side results in 1,000,000 pieces being formed, the surface area being increased from 0.93 sq. in. to 93 sq. in. It will be readily understood why an increase in fineness in core sand causes an increase in consumption of core oil.

The oil most reliable and generally useful in general engineering castings of iron and non-ferrous metals was found to be a simple linseed oil-dextrine-water mixture that was compounded in a simple cylindrical vessel stirred mechanically by a series of paddles. This was made the consistency of cream so that it could be run off, and the mixer was placed adjacent to a large pan mill in which the oil sand was made.

The introduction of oil binders of the powder type free from water, *i.e.* consisting essentially of linseed oil and dextrine or similar material, without the addition of water, is one of the most important developments in oil-sand practice in recent years. It allows all sand to be used without preliminary drying and with a consequent saving of fuel and labor, while at the same time obtaining a flexibility of production hitherto quite unknown.

Stack molding is a matter of practical interest to many foundrymen. It is usually carried out in green sand, using one drag flask, a number of mid-parts, and finally one top part. In machine-tool production, thousands of patterns may be in circulation.

The number of flasks that can be used in a green-sand stack is limited by the pressure that the lowest flask will stand, and in the case of machine flasks without bars, the safe limit of height is not much over 24 in., even with careful ramming of the drag. Indeed, the process in green sand seems only suitable for castinngs of the piston ring type, in which the metal will set quickly and terminate the interval of effective pressure of the liquid metal.

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THE only thing that interests you about non-ferrous ingot made by Michigan Smelting is the kind of castings you can make from it in your own plant. How accurately do we hold to your specifications so that wastage and spoilage will be held to an absolute minimum? On that point the "know-how" of this organization is important to you.

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**Sand May Flow**

For castings of over an in. in thickness,, the metal remains liquid for quite an appreciable time, and under the steady pressure the time factor allows heavy swelling to occur due the sand flowing under pressure.

The ratio of strength of green sand, dry sand and oil sand may be taken roughly as 5, 100 and 500, respectively, and the limit of height of stacking will be controlled by these relative strengths.

Again, the maximum height of stack may be regulated by the thickness of the casting and the minimum thickness of sand between the castings, because the metal may remain liquid long enough to destroy the organic bond material and cause partial or complete collapse of the sand under liquid pressure.

In oil sand, the stack is built of a series of blocks secured by ramming up in any suitable mid-part boxes on frames, and the blocks are made in ordinary wooden "core boxes" into which the patterns are fixed.

Several examples are presented that illustrate the castings being run through one another. A remarkable example was a 22-high stack. The castings were 30 in. diam. and 8 in. diam., one pair in each clock 3 in. thick. The castings were 1½ in. thick, having only 1½ in. sand between one casting and the next above and below. The weight of metal in the heads of basins combined is 56 lbs.

The main reason for applying stack molding to this casting was that the pressure appears to produce castings by this method free from porosity under water test, whereas the same casting is liable to be porous when cast singly in dry sand.

Oil sand plant, design of mixers, drying core racks, mechanical stokers, reclaiming oil sand lumps, core-shop machines, etc., are also discussed.

—William Y. Buchanan. *Foundry Trade J.*, Vol. 71, Dec. 9, 1943, pp. 291-293; Vol. 72, Jan. 6, 1944, pp. 9-12; Jan. 13, pp. 35-37; Jan. 20, pp. 53-54; Jan. 27, pp. 75-76; Feb. 3, pp. 93-96.

## Boron in Malleable Annealing

*Condensed from "The Foundry"*

The National Malleable & Steel Castings Co. follows the general practice of adding 0.001% B to malleable iron for accelerating the annealing process. Addition in the form of ferroboron to the ladle is preferred.

An excess of boron is to be avoided, as it may cause annealing difficulties and deterioration of quality; recovery between 70 and 100% is expected.

If alloys are present that retard annealing excessively, larger additions than 0.001% are justified. When a harmful amount of boron has been added, it is clearly evident from the microstructure, as an abnormally fine subdivision of temper carbon nodules appear near the surface of the casting.

Although boron can be used to reduce annealing times, the author prefers to use it as insurance against unforeseen annealing difficulties, such as the presence of higher than usual chromium in the heat.

... *Foundry*, Vol. 72, Apr. 1944, p. 129, 182.

# Invitation to Non-ferrous Metallurgists

LIKE other non-ferrous metals LITHIUM has been marching in the ranks of those products which are serving the Armed Forces. Outstanding contributions have been made by Lithium, and its pre-war production capacities have been greatly increased. Thus the normal growth of a young industry has been considerably accelerated, and the post-war era will find Lithium available in quantity.

IT IS anticipated that production facilities now available will tend to reduce appreciably the pre-war prices for Lithium, thus making possible more extended and economical use. Eventually, quantity application at cost approximating one half or less of pre-war prices should be feasible.

ALTHOUGH the current requirements for Lithium make it still subject to WPB allocation, Lithium metal will now gradually become available again for metallurgical applications.

THE principal commercial applications for Lithium in the non-ferrous field have been in the form of Lithium Master Alloys as highly efficient degasifying (dehydrogenizing) and deoxidizing agents for copper and certain bronzes. The applications in this field have been successful because the unique physical and chemical characteristics of Lithium are utilized in a practical and simple manner.

THE Research Staff of the Lithaloys Corporation has been devoting its efforts also to the development of novel metallurgical applications in which Lithium performs the function of an essential though minor alloying constituent.

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SUFFICIENT basic information on the unusual and metallurgically rather intriguing element Lithium can be made available to the interested metallurgical public. It is believed that by disseminating reliable information, active interest in Lithium will increase.

AN invitation is therefore extended to the non-ferrous and physical metallurgists to acquaint themselves with the chemistry and metallurgy of Lithium.

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## Chip Control with Carbide Tools

*Condensed from "Canadian Machinery"*

Although chip control is one of the least understood single factors in connection with sintered carbide tools for steel, it is absolutely essential, due to the physical danger of chips coming off at 300 to 400 ft per min. and to their interference with the work and coolant set-up.

The most satisfactory method is a ground-in chip breaker, which is a step ground into the top surface of the tool so as to cause the chip to coil up and break off. The depth and width of the breaker vary with the depth of cut, feed, cutting speed and type of metal being machined.

Since most of the heat is in the chips, correct coolant practice involves directing a heavy stream onto the chip to dissipate the heat and quench the chip; this increases the brittleness of the chip so that it is easier to break.

A good way to determine the efficiency of the chip breaker is to examine the chips. The chip should have been curled from ¾ to 3 turns before broken off. If the chip is shorter, it means that the pressure was too high, which will lead to a short tool life. If the chip is too tightly coiled, the pressure has been excessive and may lead to cracked tips, chatter, increased power consumption, etc.

It is usually best to adapt the breaker to the job. For example, it is frequently possible to use a loose chip breaker to curl the chip and guide it into the chip pan without completely breaking it; this method is especially good with light cuts, since it eliminates a narrow breaker, which may tend to decrease the tool life.

### Sizes for Chip Breakers

The width of the breaker should increase with the chip section, but with feeds of 0.003 to 0.007 in. it may be impossible to break a tough chip; in this case, the feed may have to be increased for proper chip control.

The depth of the breaker depends largely on the radius in back of the breaker; 0.015 in. is sufficient with new or correct grinders, but it may increase to 0.025 in. for worn grinding wheels. The best radius is 0.010 to 0.030 in. (the latter for larger breakers).

If the radius is too large, the chip will not be sufficiently coiled; if the radius approaches a sharp corner, the increased pressure against the shoulder will tend to break or chip the carbide. The angular type of breaker at 6 to 8° is easier to grind than the parallel type where the grinder must make a traverse stop to prevent grinding into the shank.

However, if an angular breaker is used on straight tools, the chip may be curled back so as to hit the shank and cause it to break off. It also has a disadvantage if the depth of cut varies as the width may be correct for the average depth of cut but too narrow for the maximum, in which case increased pressure, chipping and flaking will result.

A breaker parallel to the end of the cutting edge is satisfactory on light boring cuts where the chip must be broken and given directional control; it is less susceptible to chatter sometimes attendant to very light cuts. Various other types of chip breakers are discussed briefly.

The breaker should be ground after rough grinding and before the radius and cutting edge are finish ground and honed. Kerosene is the most economical and satisfactory grinding coolant, although others such as soluble oils may be used.

The steel shank must be ground away with alumina or silicon carbide wheels before the breaker is ground in the carbide. Grinding the steel shank on the diamond wheel used for the carbides will cause excessive wheel wear and possible damage.

Sometimes chips are controlled with rake angles rather than with breakers, as this method has the advantages of lessened grinding time, lower wheel costs, and no danger of cracks or checks on the tip due to grinding the breaker. Also, the negative back rake gives more strength at the tool nose.

Decreased or even negative rake angles will facilitate chip breakage by squeezing or compressing the chip until it is broken. Usually the harder the steel being cut, the greater the negative side rake, but care is needed since negative side rakes are apt to create heavy loads on the tool.

If the chips are excessively springy, it

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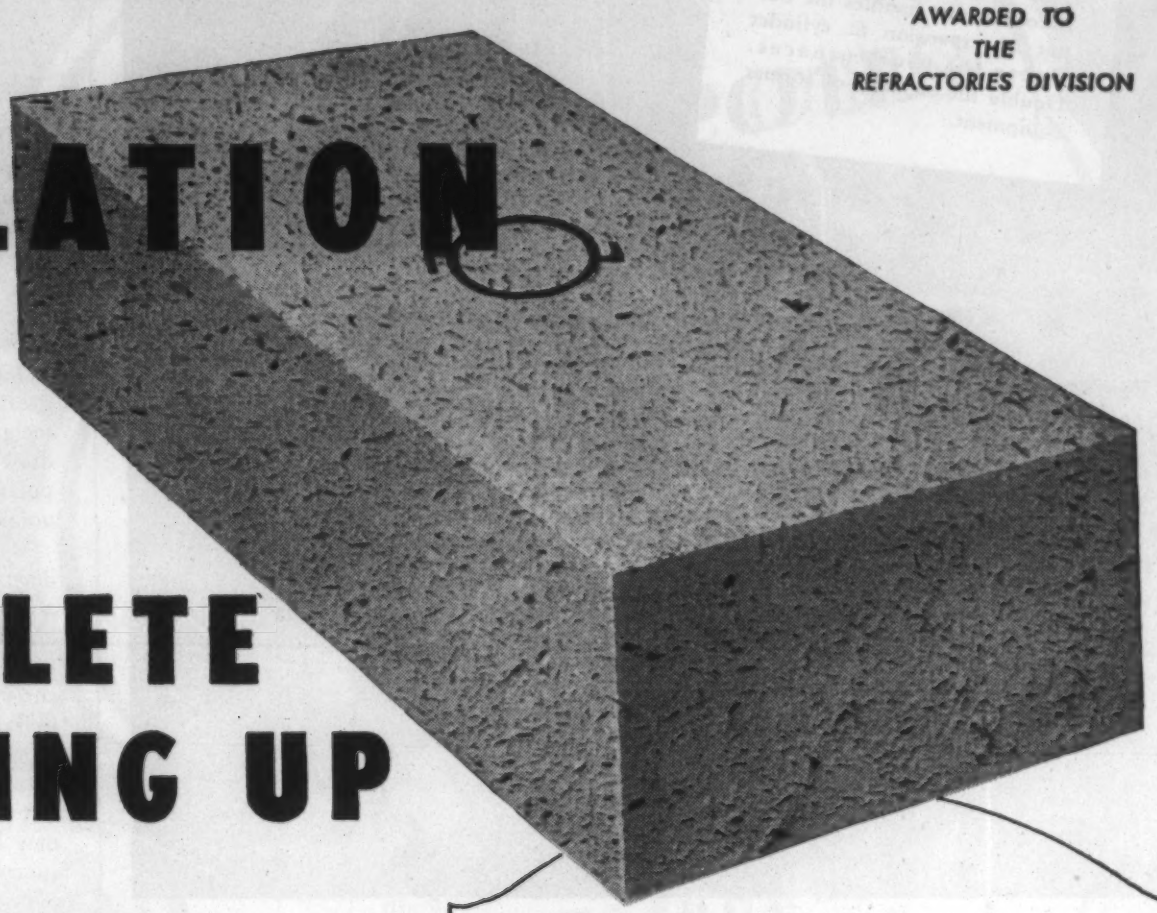

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*Btu. per sq. ft. per hr. per deg. F per inch, as determined under ASTM Method C-182-43T.

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may be necessary to combine both methods of chip control; *e.g.*, breakers and negative or zero rake angles.

—E. Almdale. *Canadian Machy.*, Vol. 55, Feb. 1944, pp. 87-88; 160-161.

## Lubrication in Deep Drawing

*Condensed from "Sheet Metal Industries"*

The basic requirements for successful deep drawing lubrication are: (1) Area of actual contact between metals must remain very small; (2) as far as possible, the metals should be prevented from coming within the zone of attraction of each other; and (3) the temperature must be kept to a minimum.

Lubricants for deep drawing must have greater attractive forces for metals than the metals have for each other. In the deep drawing of thin metals, lubricants with polar chains are generally used as the polar head is adsorbed by the metal.

If there is extreme pressure (as in the deep drawing of heavy gage metal), the adsorbed lubricant film is squeezed out and fusion occurs over a very minute area of actual contact. Under extreme pressures, seizure occurs with scoring as its first indication.

Simple long-chain fatty acids are unsuitable under these conditions. Protective films, such as chloride or sulphides, may be used; other alternates are solid adjuncts or metals that melt at a lower temperature than either the metal of the tool or of the work being drawn (such as lead or tin).

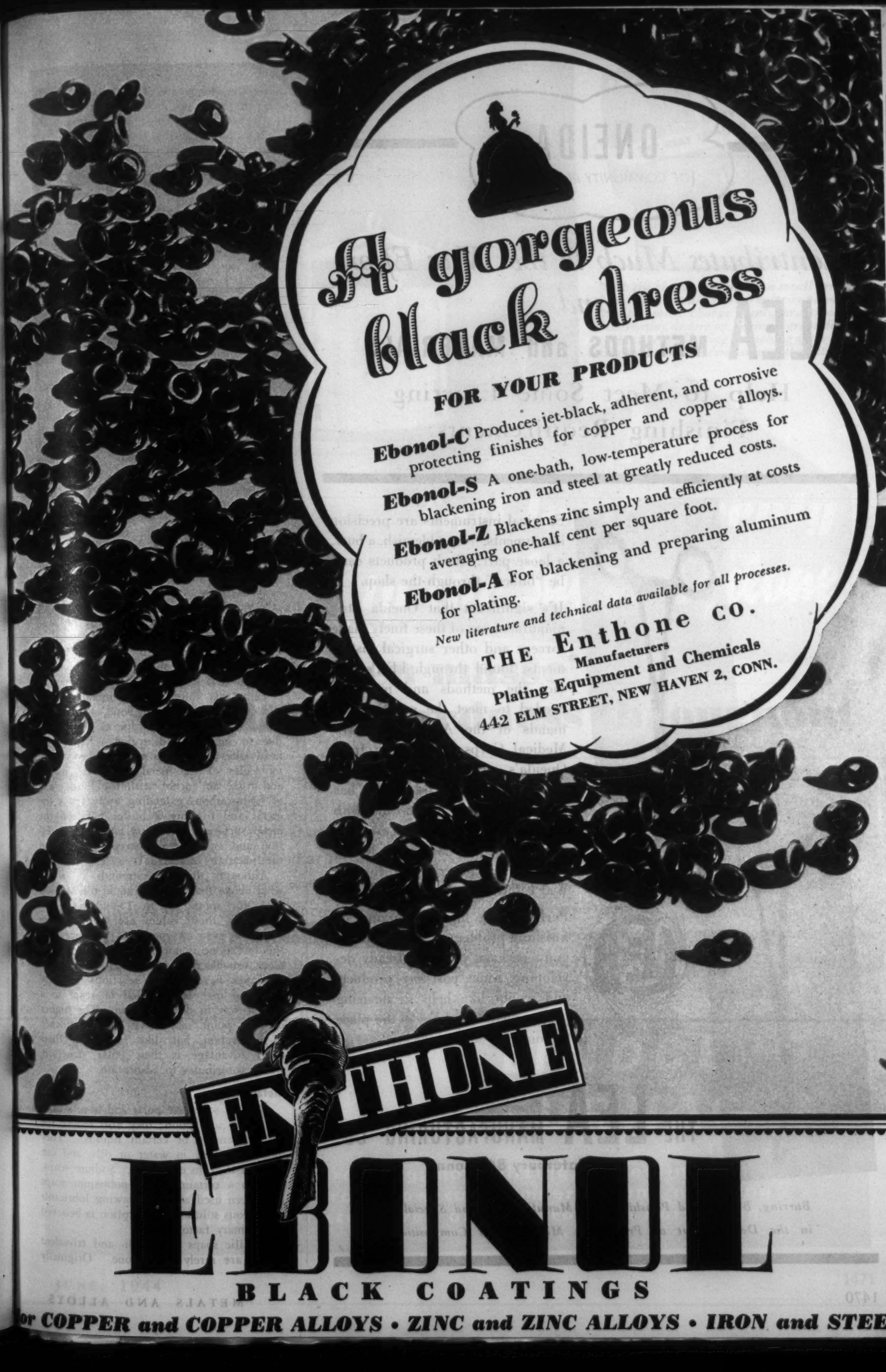
Soft dies wear rapidly and are more prone to fouling and scoring than harder dies. Jet hardening, which gives maximum hardness on the bore with a tough core, is best. If the die wear is excessive, attention should be paid to the hardening process and to the possibility of improving the working surface by chromium or other deposits (if the cup is stripped from the punch by the rear of the die proper, an auxiliary stripper must be used or the chromium will flake).

If the die is oversize after a short run, the cause is probably inefficient hardening. Only if the die is satisfactory can the working life be increased by the selection of an efficient lubricant.

If small local welded spots are found on the surface that can be filed off without damage, the trouble is due to welding of loose particles of metal, and the problem may be solved by another lubricant, for example a lubricant with a high proportion of a suitable solid lubricant, as montmorillonite in conjunction with unsaturated hydrocarbons.

Single line scoring is usually due to the presence of foreign matter or loose particles of metal on the work. It necessitates the polishing of the tools, thereby shortening their life and requiring extra labor. Cleanliness is usually the only answer.

However, if the lubricant has a particularly low surface tension, it will act as both a lubricant and a detergent. If the score patch is larger, it is considered as fouling, caused by a breakdown of the lubricant over a relatively larger area due to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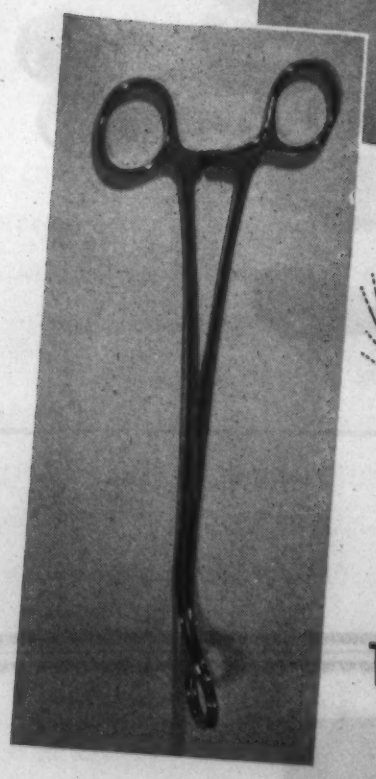

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excessive temperature or pressure resulting in metal to metal contact.

It can be prevented by improving the lubrication, reducing the speed of operation or reducing the amount of work at a particular stage. It is necessary to distinguish carefully between scoring and fouling, as both affect the die and both give a torn or scraped surface of the work, but the cure is different.

**Types of Lubricants**

In general, lubricants may be divided into (a) materials forming a basis for general lubrication, but totally unsuited alone for extreme conditions of temperature and pressure; and (b) adjuncts suitable for improving these materials to make them suitable for deep drawing.

There is considerable difference among mineral oils depending on their origin (*i.e.* Pennsylvania and California oils had the same viscosity at 130 F., but at 20,000 p.s.i. the California oil had three times the viscosity of the other). Mineral oils are affected by increases in pressure more than fatty oils at normal temperatures, but both are affected to the same degree at high temperatures. Practically all mineral oils, irrespective of their viscosity at normal temperatures, have film rupture strengths of 4,000 to 5,000 p.s.i.

Since the pressures in deep drawing are far in excess of these figures, any such film will soon rupture. Although there is some adsorption of the oil, there is no polar bond, so any adsorption is easily replaced by another metallic surface. Some mineral oils are liable to form asphalt at high temperatures and thus upset lubrication.

Fatty oils differ from mineral oils in that all contain a polar bond, which contributes to the greater value as a lubricant due to increased adsorption. The polar head takes a position near to the surface molecules of the metal to be lubricated, and form an anchor with the long chain of hydrocarbons extending away from the metal and forming a buffer between the metal surfaces that resists lateral compression and is not easily swept away when the pressure increased.

Although the film strength is somewhat above that of the mineral oils (8,000 p.s.i. for sperm oil to 15,000 p.s.i. for rape oil), these values are bound to be exceeded even at moderate pressures, so this fact alone is not enough to make them more suitable for high pressure lubricants.

Waxes have similar reactions to fatty oils, and may be expected to react in a similar way in deep drawing. The higher melting point may have some influence in lubrication, but, like fatty oils, their main advantage is their polar structure, which contributes to adsorption.

**Metallic Soaps**

Metallic soaps are polar and have a high degree of adsorption; they also reduce the surface tension of certain liquids. They may be soluble in water or oils, and can be used to form emulsions. Sodium soaps, and, to a certain extent, potassium soaps have been used as deep drawing lubricants in aqueous solutions; adsorption is believed the primary factor.

Metallic soaps of the di- and tri-valent metals are rarely used alone. Originally

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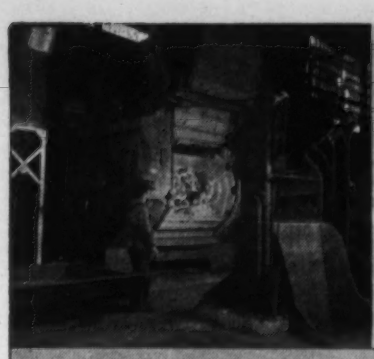
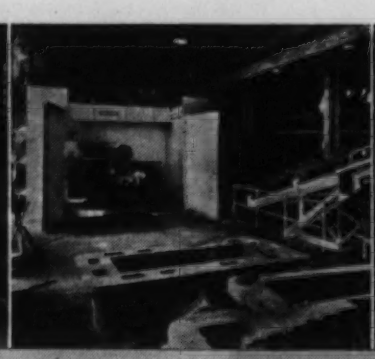

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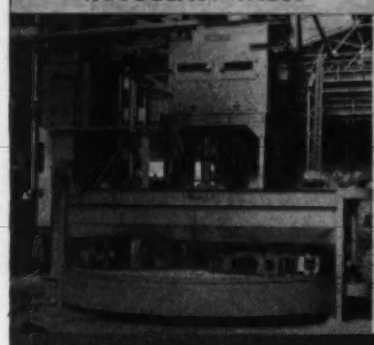

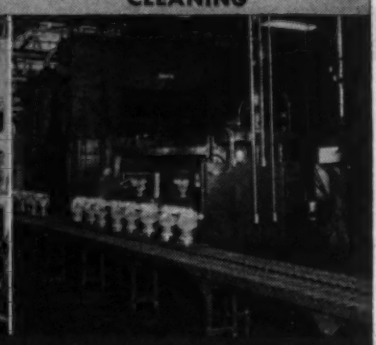

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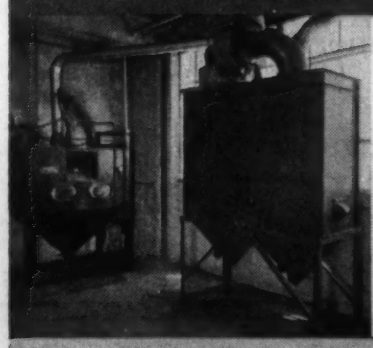
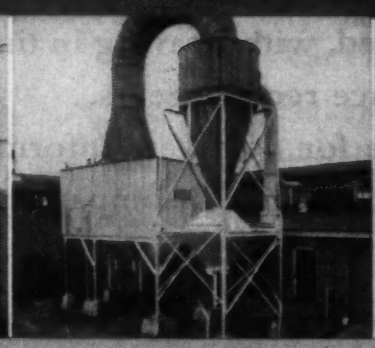
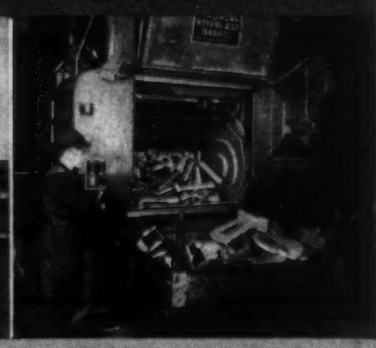

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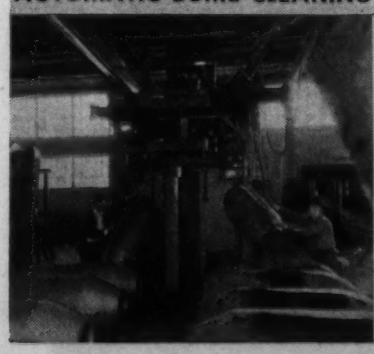
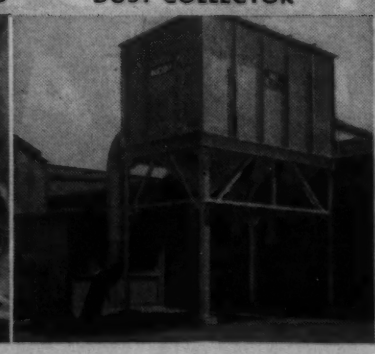
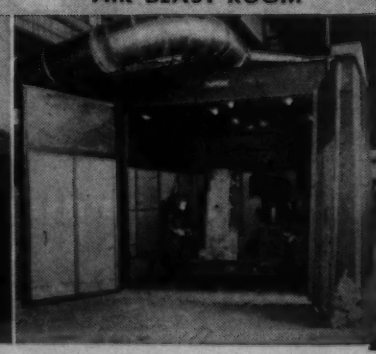
DUST COLLECTOR
DUST COLLECTOR

ROTOBLAST BARREL
AIR BLAST ROOM


they were used as anti-oxidants, but it was then noticed that they improved the film strength of hydrocarbon oils and further proved very useful in high pressure lubrication.

Mineral oils plus metallic soaps have film breakdown strengths much the same as those of the better fatty oils, but the lubricative properties under extreme pressure are far superior. Part of the success may be due to the metallic radical; *i.e.*, lead oleate dissolved in oil may decompose to form metallic lead, which acts as a low melting point solid adjunct.

Soluble oils is often a misnomer as applied to emulsions. Their advantages over soap solutions are that they are stable in acid and alkaline solutions and do not precipitate salts. They are polar, strongly surface active, and have some degree of adsorption. They are usually soluble in both water and oils, and may be used in forming emulsions. True soluble oils are not often used neat for deep drawing as their power of resisting extreme pressures and high temperatures is insufficient.

Chlorine, usually added as chlorinated hydrocarbons, is used with some success in high pressure lubricants. Sulphur is the most successful of all lubrication additives. If it is part of the molecule of the lubricant, it does not play any important role; if in simple solution in the lubricant, it is very active.

Complex organic sulphur-bearing compounds are less active. Phosphorus is another agent, but it is not as effective as sulphur and chlorine. All these extreme pressure additives are anti-oxidants. The mechanism of improvement is not known definitely, but it is believed to be due to the formation of acid.

Solid lubricants keep metallic surfaces apart purely by mechanical resistance to deformation, as there is no adhesive linkage to the metal. The lubrication is due to the oil in which the solid is suspended. The best crystalline structure is a series of planes with weak linkage, such as graphite. One of the drawbacks of these additions is the difficulty of removal, although montmorillonite does not have this disadvantage.

Sometimes, copper films are very helpful in deep drawing. Likewise, a fine black carbon deposit formed by annealing undegreased metal in the absence of air has helped in the drawing of beryllium copper.

There are certain limitations in choosing a lubricant. Fatty materials should not become rancid, as this may easily produce instability (a little salicylic acid will prevent this in straight fatty substances). Any lubricant promoting rusting should be avoided. The lubricant must be capable of ready and simple dilution, preferably with water.

**Method of Application**

The method of application of the lubricant must be considered. Immersion is most common (sometimes the soaking period is important), but strip may be fed through rollers mounted under a trough of lubricant and in light drawing on automatic units, the lubricant is frequently sprayed through series of jets onto blanks as these pass to the punches.

If the lubricant has adequate adsorptive

*Introducing*

# PENNSALT CLEANER EC-10

REG. U. S. PAT. OFF.

## A PRODUCT OF RESEARCH

**This new organic type cleaner employs a new money-saving principle. It actually removes soil which alkaline cleaners won't budge in the short time present high production schedules allow. Drawing, polishing and buffing compounds as well as lubricants and cutting oils are removed in a single operation. It is particularly effective as a precleaner before electroplating.**

**Put Pennsalt EC-10 to work for you. For further information write our Special Chemicals Division. Address Dept. MA.**

**PENNSALT EC-10 was designed for two types of cleaning:**

**1. DIP CLEANING:** Removes deposits by first saturating the soil, which is then burst off by the surface emulsion action of the rinsing operation. When rinsed and dried, parts are ready for painting or—with an added alkaline dip and rinse—ready for plating. Eliminates hand-scrubbing, keeps excess oils from contaminating alkaline cleaners, inhibits rusting between operations and drastically reduces cleaning time.

**2. SPRAY WASHING:** Can be used in conjunction with water in a spray power-washer or pressure gun. A very small quantity of EC-10, when added to water, forms an effective spray cleaning medium.

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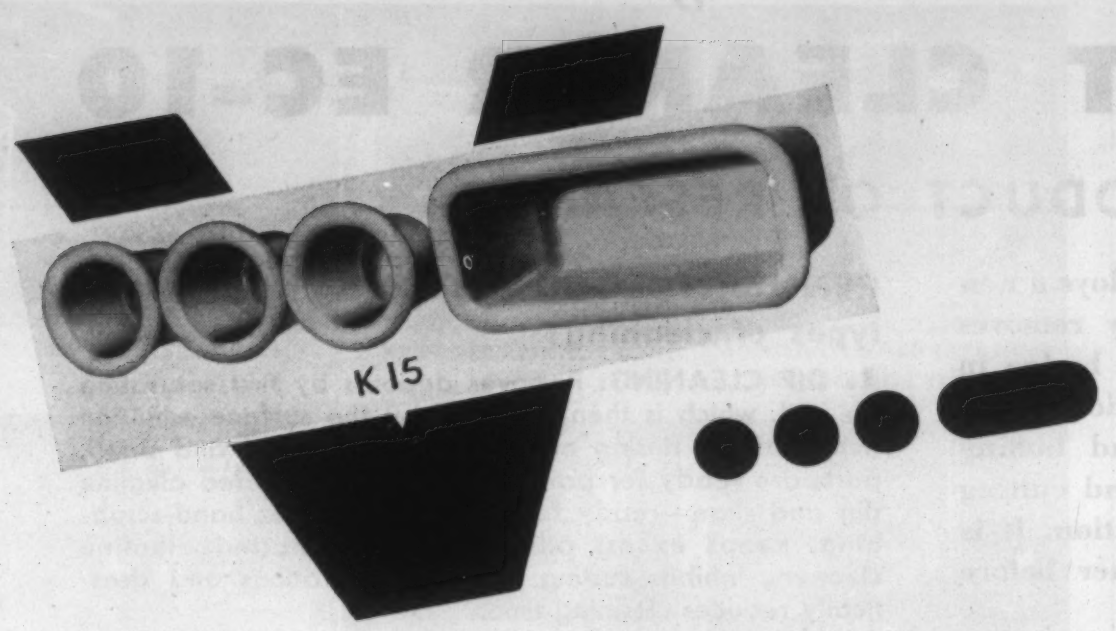
*TRADE-MARK REG. U. S. PAT. OFF.



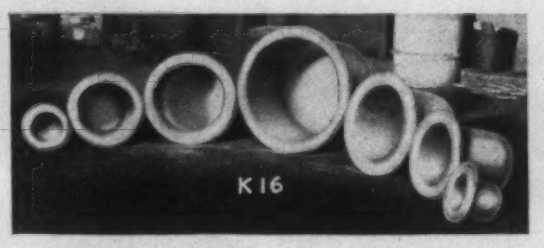

These "three-dots-and-a-dash," as well as other sizes and shapes of Amsco Alloy pots and pans, are working for Victory through the aircraft and ordnance parts heat treated in them.

Proper analysis is not enough! Sound metal is equally important. Controlled analysis, coupled with rigid x-ray inspection and high pressure tests, assure you of optimum performance from each Amsco Alloy pot.

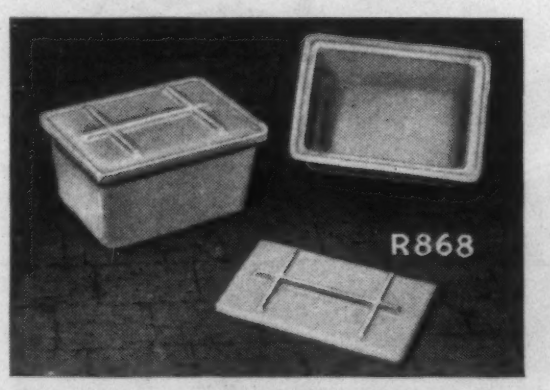
Boxes, trays and furnace fixtures are made to the same standards of skill and quality as Amsco pots. Laboratory controlled production insures the good foundry practice that results in sound castings.

Amsco Alloy pots, pans and boxes for carburizing and heat-treating are available in many different patterns: small, medium, large; round, oblong, square; shallow or deep.

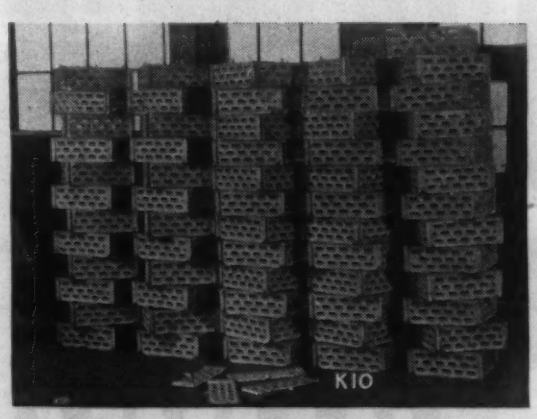
Ask for Bulletin 1041-A on Amsco Alloy heat treating containers.




*A few of the many sizes of Amsco Alloy cyaniding pots.*




*Amsco Alloy non-sectional carburizing box. Any size or shape is also available in the patented sectional "Flexbox" design.*




*These "Flexboxes" fit into trays so that small pieces charged into them will not roll off, thus increasing carrying capacity of the trays.*

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Chicago Heights, Illinois
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properties, the punch and die rapidly become coated with an adequate film, but in starting a run with new tools, it is sound practice to dress the punch and die with undiluted lubricant before the first run.

If thorough degreasing is not possible before annealing, the lubricant must be one that will burn off completely (*i.e.* many saponified fatty acids). Mineral oils may burn off, but they generally leave carbon and pitch-like residues on the surface. Fatty oils may produce some localized attack during annealing, giving poor surfaces for latter draws.

Apart from action in the furnace, corrosion may result if the work is left in contact with drawing lubricants for any length of time. If it is necessary to use trichlorethylene for degreasing, the lubricant must be wholly soluble in it, and must not contain any of the solid lubricants or adjuncts frequently added to reduce tool wear.

If the basis of the draw compound is aqueous, it is best to use aqueous degreasing (alkaline solutions with special surface active agents to give emulsification, followed by rinsing). If inert material, such as talc, is used in mineral or fatty oil, the oil is removed in an organic solvent, but the solid must be removed by mechanical brushing.

Colloidal graphite in a lubricant must be removed by aqueous degreasants in spray type plants. Agitated immersion is better than stagnant, while spray types are widely used. With organic solvents, vapor degreasing is more economical than immersion.

As bench drawing from strip is a very severe operation, a special lubricant is necessary in which an efficient solid lubricant is combined with a fatty acid compound of high adsorptive value. The lubricant may either be used hot (105 F.) and the coil cooled before drawing, or it may be diluted with a chlorinated solvent that is allowed to evaporate before drawing.

Many features of deep drawing are also common to wire drawing. Soap is widely used as well as electrolytically deposited copper coatings.

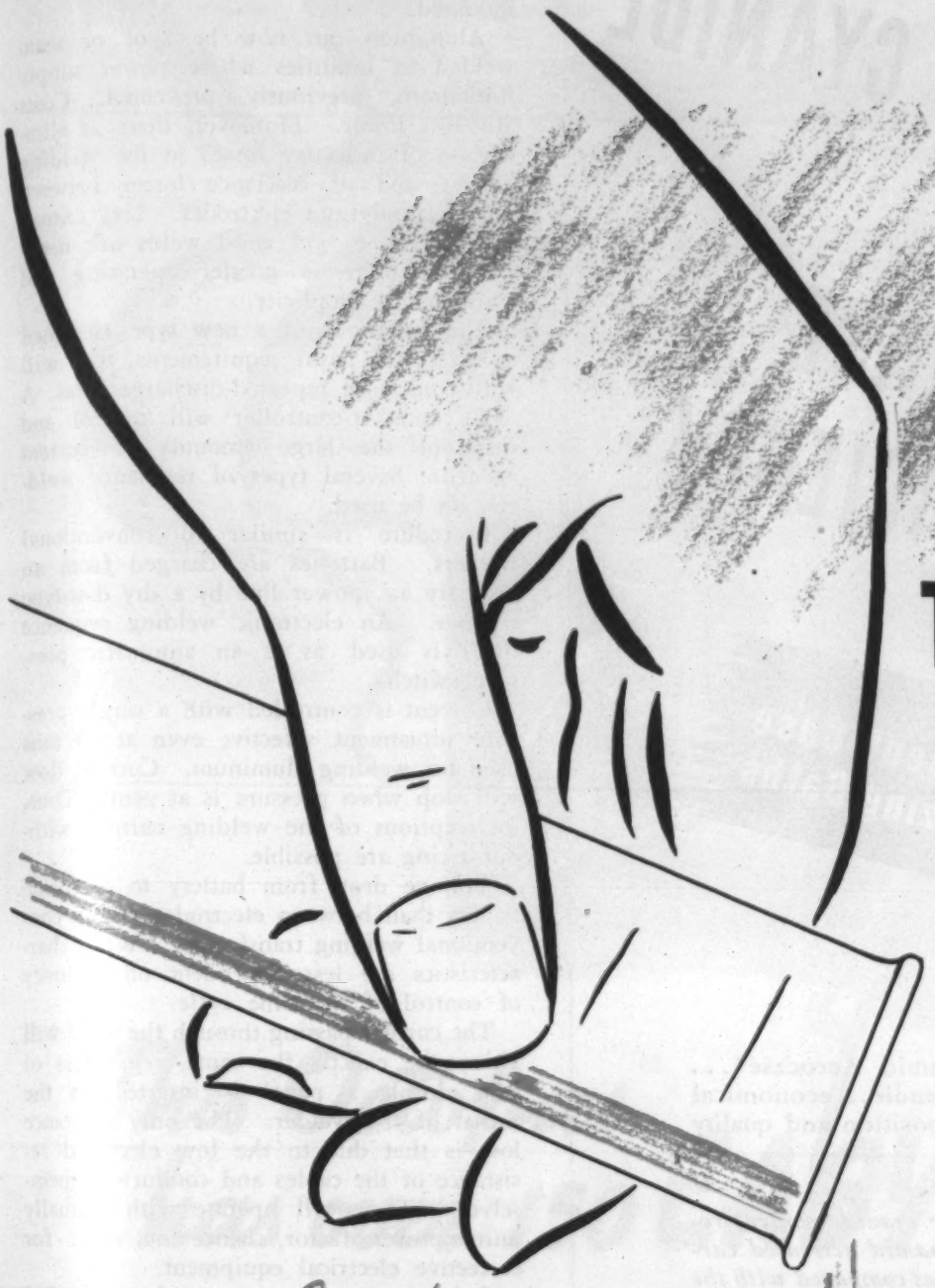
Most of the successful lubricants form an acid at some stage of decomposition; the explanation of the efficacy of acid may be the creation of reducing conditions. A good lubricant should be non-corrosive to tools, work and operator's skin; free from objectionable feel or odor; easy to apply and remove; readily available and economical; and, above all, have good lubricating properties.

—H. A. H. Crowther, F. D. Liddiard & K. I. Marwood. *Sheet Metal Inds.*, Vol. 18, Oct. 1943, pp. 1733—1738; Nov. 1943, pp. 1915-1920; Dec. 1943, pp. 2099-2105; Vol. 19, Jan. 1944, pp. 81-83, 88.

## Storage Battery Welding

*Condensed from "Welding Engineer"*

The first practical d.c. resistance welder is announced by Progressive Welder Co., Detroit, already being used in welding aluminum for aircraft assemblies. No radical redesign is involved as to resistance welders, though existing types of welding



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**MAC DERMID INCORPORATED Service Engineers are always more than willing and able to help you with your most complex metal cleaning, finishing or plating problems.**

**This type of personal service to the metal finishing industry was first established over twenty years ago — shortly after the first world war and has led to the introduction of many of the mordern improvements that are now speeding up war production and saving valuable metals through positive results.**

**No matter what your cleaning problem may be — don't hesitate to request the services of one of our qualified representatives. You will be amazed at the tremendous improvements that have been recently introduced for cleaning, plating and finishing procedures and the many new compounds for cleaning that are now available for war and post-war cleaning.**

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## METEX ZINC STRIPPER

**Here is a typical example of the many new compounds recently developed by MAC DERMID INC. for specific problems.**

**METEX *alkaline* ZINC STRIPPER has been originated for the speedy removal of zinc and dichromate coatings in one operation of less than one minute and is guaranteed to produce superior results . . . Additional information on request.**

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**Providing case depths of .001" to .150" Cyanamid Aerocase*... Aerocarb*...and Aerocarb Deepcase are easy to handle...economical to use...and give unmatched stability of bath composition and quality of cases produced.**

**AEROCARB**
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Usable temperature range of 1300°F.-1650°F....non-hygroscopic and non-corrosive...eutectoid case ...low cyanide decomposition rate ... high fluidity ... low drag-out losses.

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**—Maximum Case Depths**

Operating temperature range of 1700°F.-1750°F.... penetration rate equal to gas carburizing...low cyanide loss ... easy to control.

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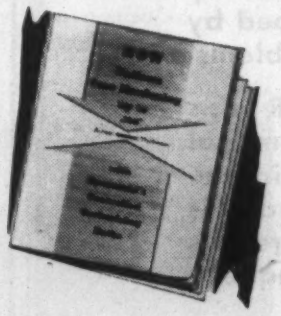
Usable temperature range of 1250°F.-1650°F....density of 110 pounds per Cu. Ft. at 1500°F.... maximum rate of case penetration ... hypereutectoid case ... flexibility of usage permits maximum carburizing and "neutral" type hardening with same materials... easy to control.

★Note: *Lower cyanide content required in Cyanamid activated carburizing baths as compared with the amount required in the non-activated types of cyanide case-hardening compounds.*

**Have You Obtained Your Copy Of This Important New 32-Page Reference Text On Case-Hardening and Carburizing?**



If you require assistance in the solution of metal treating problems to which salt baths are applicable, you are invited to avail yourself of the facilities of our laboratories and the experience of our technical staff. Write for it today on your company letterhead.

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**AMERICAN CYANAMID**
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machines and guns must be somewhat modified.

Aluminum can now be spot or seam welded in localities where power supply limitations previously prevented. Costs are also lower. Moreover, there is elimination of inductive losses in the welding "loop" and of reactance losses between power supply and electrodes. Less critical adjustments to get good welds are needed, and there is greater operating and maintenance simplicity.

The battery is of a new type, designed to meet stiff naval requirements, that will withstand high repeated-discharge rates. A new contactor-controller will control and interrupt the large amounts of current needed. Several types of resistance welders can be used.

Procedure is similar to conventional welders. Batteries are charged from an ordinary a.c. power line by a dry disc-type rectifier. An electronic welding sequence timer is used, as is an automatic pressure switch.

Current is controlled with a single pressure adjustment, effective even at 25 tons used for welding aluminum. Current flow will stop when pressure is at zero. Thus, interruptions of the welding current without arcing are possible.

Voltage drop from battery to electrode is less than between electrodes and a conventional welding transformer. Weld characteristics are less dependent on accuracy of control of the time cycle.

The current passing through the weld will always be exactly the same, regardless of how deeply a panel is inserted in the throat of the welder. The only reactance loss is that due to the low electrical resistance of the cables and conductors themselves. They will operate with virtually unity power factor, hence no need for corrective electrical equipment.

Only a normal amount of mechanical skill is needed for maintenance. The only inspection is a routine one of once a week, with water added to battery.

—*Welding Engr.*, Vol. 29, Mar. 1944, p. 45.

## Heat Treating Aluminum Alloys

*Condensed from "Automotive and Aviation Industries"*

Arguments as to the merits of salt baths and air furnaces have occurred from time to time. The experience of Goodyear Aircraft Corp. has been that each type has enough advantages that the use of both is justified in the aircraft industry.

Salt baths being used are of the immersed electrode type. An electrical field around the electrodes sets up a stirring action in addition to that caused by convection currents. Parts heat-treated should be free from dirt, grease, etc., because a sludge will form that is more viscous than the salt solution.

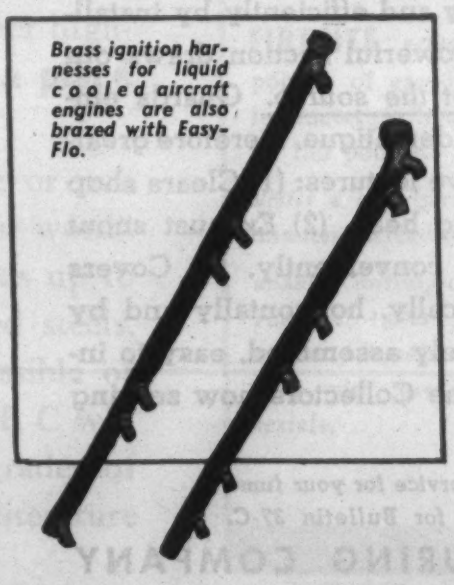
The heat content of the salt is high enough that the bath temperature does not drop appreciably when the furnace is opened. Because of this, it is possible to charge simultaneously a wide variety of gage sizes requiring different heat treating cycles. Since an entire load from a salt bath need not be quenched at once, it is possible to eliminate the need for large

# This "Octopus" has over 150 EASY-FLO brazed joints

It's the ignition harness for a 2000 hp. double, air cooled airplane engine. It is mounted right on the front of the engine and has to withstand severe vibration, engine heat and the drop to sub-zero temperatures when the plane goes "upstairs".

Its numerous parts are brazed together with Easy-Flo—the low temperature silver alloy now used so widely for this work, because it assures joints that are high in strength and ductility—and makes it possible to produce them fast and economically.

And for these same reasons Easy-Flo is being used today to a truly amazing extent in airplane construction and on metal joining operations throughout all industry—and will have a place of vital and growing importance in post-war production.



*Brass ignition harnesses for liquid cooled aircraft engines are also brazed with Easy-Flo.*

If the joining of ferrous, non-ferrous or dissimilar metals is part of your production—present or future—it is almost certain that on many operations Easy-Flo will give you better joints, higher production and lower costs. Check up on the advantages Easy-Flo offers ***now***—and start getting these benefits as soon as you can. ***Bulletin 12-A*** will give you full Easy-Flo details. Write for your copy now.

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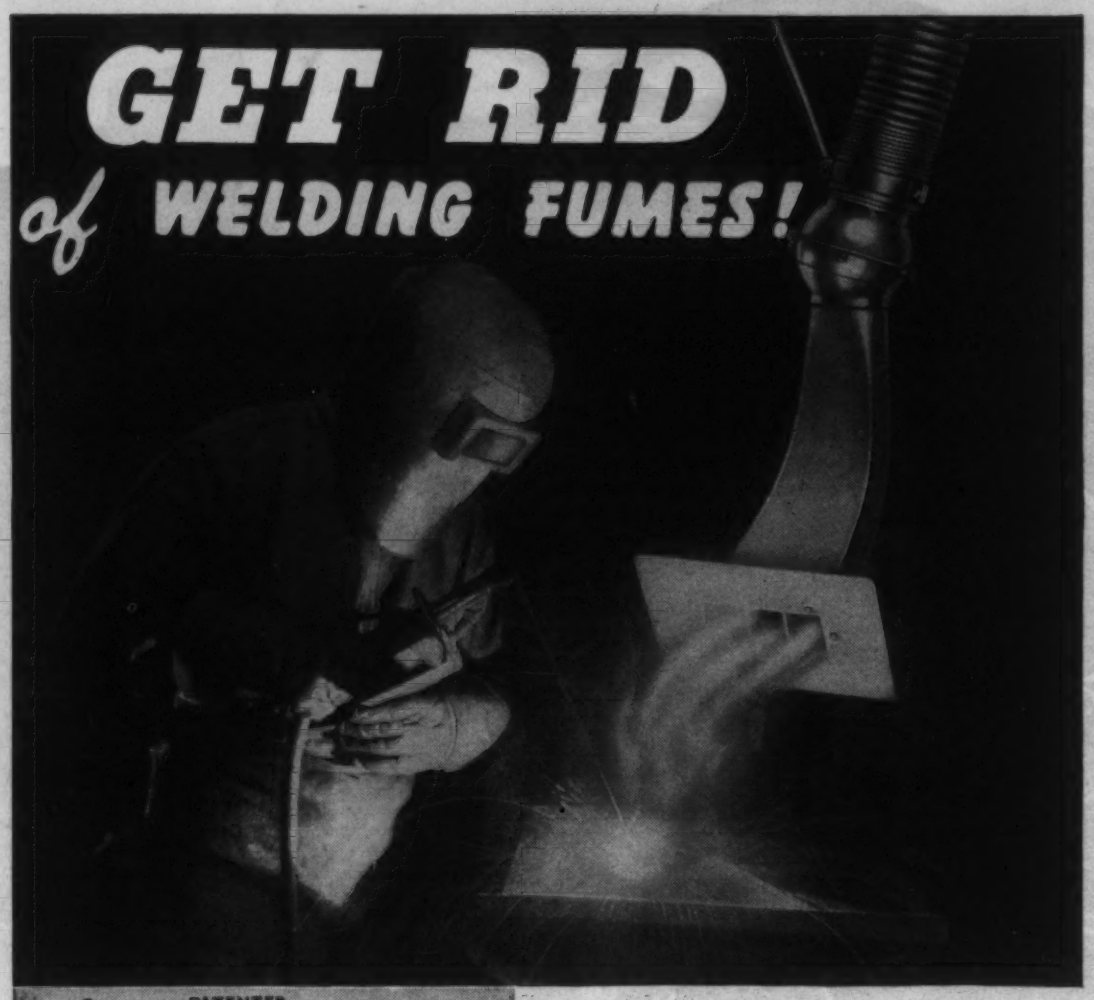


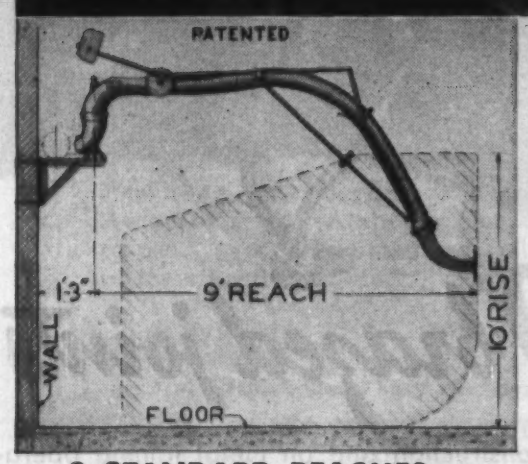


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3 ft., 9 ft. and 15 ft. radius. Arm extended for maximum reach. Note very wide working range.

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**DRAWS OUT GASES, SMOKE and HEAT**
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storage ice boxes prior to stretching, forming, etc.

The rate of heat transfer from salt to alloy is so rapid that the time of immersion can be considered the time "at heat" for the usual gages heat treated. On the other hand, the high heat content of the salt bath reduces the utility of this type of furnace, since it is not practical to heat-treat parts requiring different temperatures because of the time required to change the temperature of the bath.

Parts heat treated are usually suspended from racks or handled individually if too large. Because of the shape of these salt baths, the variety of shapes and sizes heat treated, and speed of quench, it is difficult to use mechanical handling devices.

The air furnaces are of the circulating air types. They are used for heat-treating sheet, plate, extrusions, rivets, etc. Rivet furnaces are of cylindrical type with a fan in the bottom. Furnaces for sheets, plate and extrusions are the bottom charging type. After heat-treating, the charge is quenched.

Test results show that the metal temperature lag behind chart temperature is dependent on both the size of the load and gage of material. Care should be taken in choosing gages of clad material, because the length of heating cycle must be set for the heaviest gage.

The salt used is the nitrate of either potassium or sodium, or a mixture of both. The pH of the bath should be checked periodically. If it becomes basic, potassium dichromate is added.

—James Snider. *Automotive & Aviation Inds.*, Vol. 90, Mar. 1, 1944, pp. 40-41, 50.

## Aluminum Alloy Heat Treatment

*Condensed from*
*"Zeitschrift für Metallkunde"*

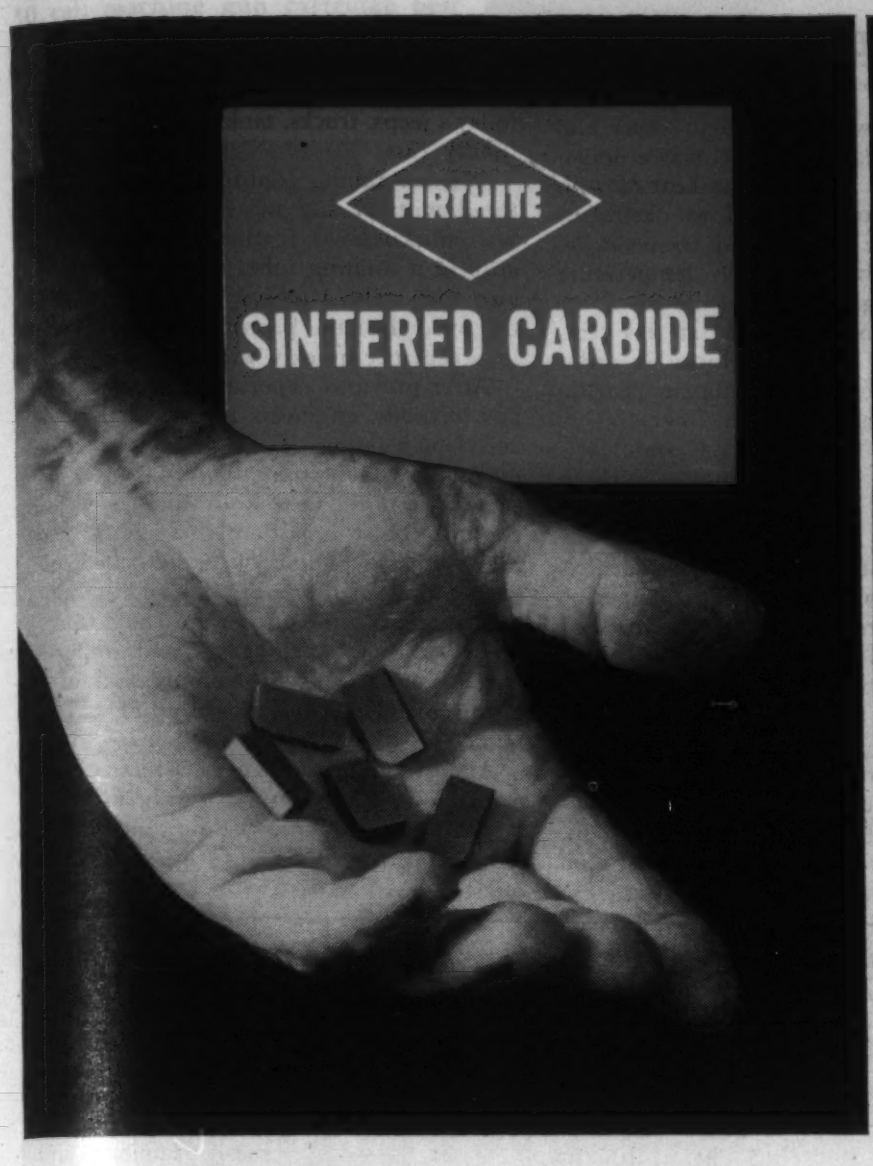
The effect of different kinds of heat treatments on a precipitation-hardened commercial aluminum alloy of the following composition was investigated: 2.6 Cu, 1.8 Mg, 0.65 Mn, 0.40 Fe, 0.29 Si, 0.17% Ti, bal. Al. The alloy melts, solidifies, and becomes heterogeneous, respectively, at 1211, 1065 and 889 F.

The optimum solid solution anneal was 80 min. at 932 F. Precipitation hardening for 6 hr. at 392 F. yields a maximum hardness of over 100 Brinell (2.5/62.5/1). Samples thus hardened were then exposed to heat "shocks" of 1 sec. to 20 hr. at seven temperatures between 482 and 1472 F., followed by annealing at 392 F. for various lengths of time.

The solid solution hardness was restored in 1, 3, 10 and 60 sec., respectively, at 1472, 1292, 1112, 932 F. Subsequent hardening at 392 F. showed the sequence of cold hardening and hot hardening, the transition being characterized in some cases by a marked temporary drop in hardness.

Samples of maximum precipitation hardness were exposed to 482, 572 and 662 F. for longer periods of time. Contrary to expectations, the hardness drops and then rises again through a maximum at 482 F. This hardness anomaly could also be produced by other thermal treatments discussed at great length.

—H. Borchers & O. Castellani. *Z. Metallkunde*, Vol. 35, June 1943, pp. 128-136.



# THERE ARE PLACES FOR BOTH . . .

Firth-Sterling, long specialists in making steels for shop tooling, early recognized the possibilities of carbides as a means of extending the improvement in shop practice brought about by the super high-speed steel—CIRCLE C. **But, there is a place for both . . .**

Where the highest speeds are obtainable or materials are hardest, FIRTHITE is the "last word" in a cutting material. It is used at speeds up to ten times those possible with high-speed steels. Where speeds above average are permissible or materials are "on the hard side," CIRCLE C will cut *at least* 25% faster than ordinary grades of high-speed steel. Send for descriptive literature on these remarkable materials.

*For instance:*

**FIRTHITE** *removes* 730 pounds of gray-iron casting metal per hour instead of 180 pounds;

*drills* a gun barrel in 23 minutes instead of 1 hour;

*enables* milling-cutters to run at 1,000 feet per minute instead of 100 feet with previous materials.

*For instance:*

**CIRCLE C** *machines* hard die blocks in 28 hours instead of 42 hours . . . doubling production between grinds — versus regular high-speed steel;

*turns* two to ten times more pieces of heat-treated alloy steel between grinds than other high-speed steels.

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The Desalting Kit was developed by chemists and engineers at Permutit, and accepted by the U. S. Navy, Army and Air Transport Command.

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## Annealing Steels from Rolling Heat

*Condensed from "Stahl und Eisen"*

Experiments were made to find out whether soft-annealing of steel was economically possible by utilizing the heat of rolling or hot-deformation, and to determine the most suitable rolling and temperature, the most favorable inception temperature from the rolling heat, the duration for which the steel is to be held at this temperature, and the cooling velocity in order to obtain a structure of granular pearlite that is best for the soft state.

A ball bearing steel with 1 C and 1.5% Cr was used for the experiments, as here the structure is of utmost importance. The results show that annealing from rolling heat is advantageous, and the annealed structure of granular pearlite is superior as regards uniformity to that obtained in the present usual annealing method.

By employing correct rolling temperature and cooling in air to close above $Ar_1$, with subsequent annealing, an excellent annealing structure is obtained, as well as similar economic advantages, such as in the hardening of steel from rolling heat. This holds good for a great number of tool and structural steels.

| Test No. | Temp. °C. | Corresp.* °C. | Cooling velocity in the temp. ranges of | | | | Obtained annealing structure |
|---|---|---|---|---|---|---|---|
| 1 | 1000 | 700 | 700-650° with 3°/hr. | 650-600° with 10°/hr. | 600-550° with 25°/hr. | — | coarse cementite mesh, laminar and granular pearlite. |
| 2 | 1000 | 750 | 750-630° 5°/hr. | 630-600° 10°/hr. | 600-550° 25°/hr. | — | medium cementite mesh, laminar and granular pearlite. |
| 3 | 850 | 700 | 700-650° 3°/hr. | 650-600° 10°/hr. | 600-550° 25°/hr. | — | P12/P13 |
| 4 | 850 | 750 | 750-630° 5°/hr. | 630-600° 10°/hr. | 600-550° 25°/hr. | — | P13/P14 |
| 5 | — | 870 | 870-700° 10°/hr. | 700-650° 3°/hr. | 650-600° 10°/hr. | 600-550° 25°/hr. | cementite mesh and laminar pearlite |
| 6 | — | 870 | 870-700° salt bath | 700-650° 3°/hr. | 650-600° 10°/hr. | 600-550° 25°/hr. | P12 |

** Cooling from temperatures corresponding to the beginning of rolling to temperatures corresponding to the beginning of annealing took place in air. The tests under No. 3 and 4 represent favorable conditions for the whole process.*

A tentative schedule for the determination of suitable starting temperatures and cooling velocities for obtaining a satisfactory annealing structure (granular pearlite) is presented in the above table

—R. Schäfer & E. Langenbach. *Stahl u. Eisen*, Vol. 63, May 20, 1943, pp. 399-402.

## Oxyacetylene Tube Welding

*Condensed from "Welding Journal"*

In certain applications, welded tubing can be used to greater advantage than either solid rod or seamless tubing. Where a premium is placed on lightness or strength, tubing is superior because it is stronger for its weight. Core metal, not present in tubing, contributes the least strength per pound.

For this reason, tubing has supplanted solid cylindrical bars and shafts in such light-weight, high-strength members as automotive torque tubes—power transmitters in today's jeeps, trucks, tanks and in tomorrow's luxury cars.

Welded tubing could be easily manufactured without any measurable variation in wall thickness—a feature of prime importance in a rotating tube. It has been proved also that welded tubing is even stronger at the weld than the parent metal. This made its acceptance quickly widespread.

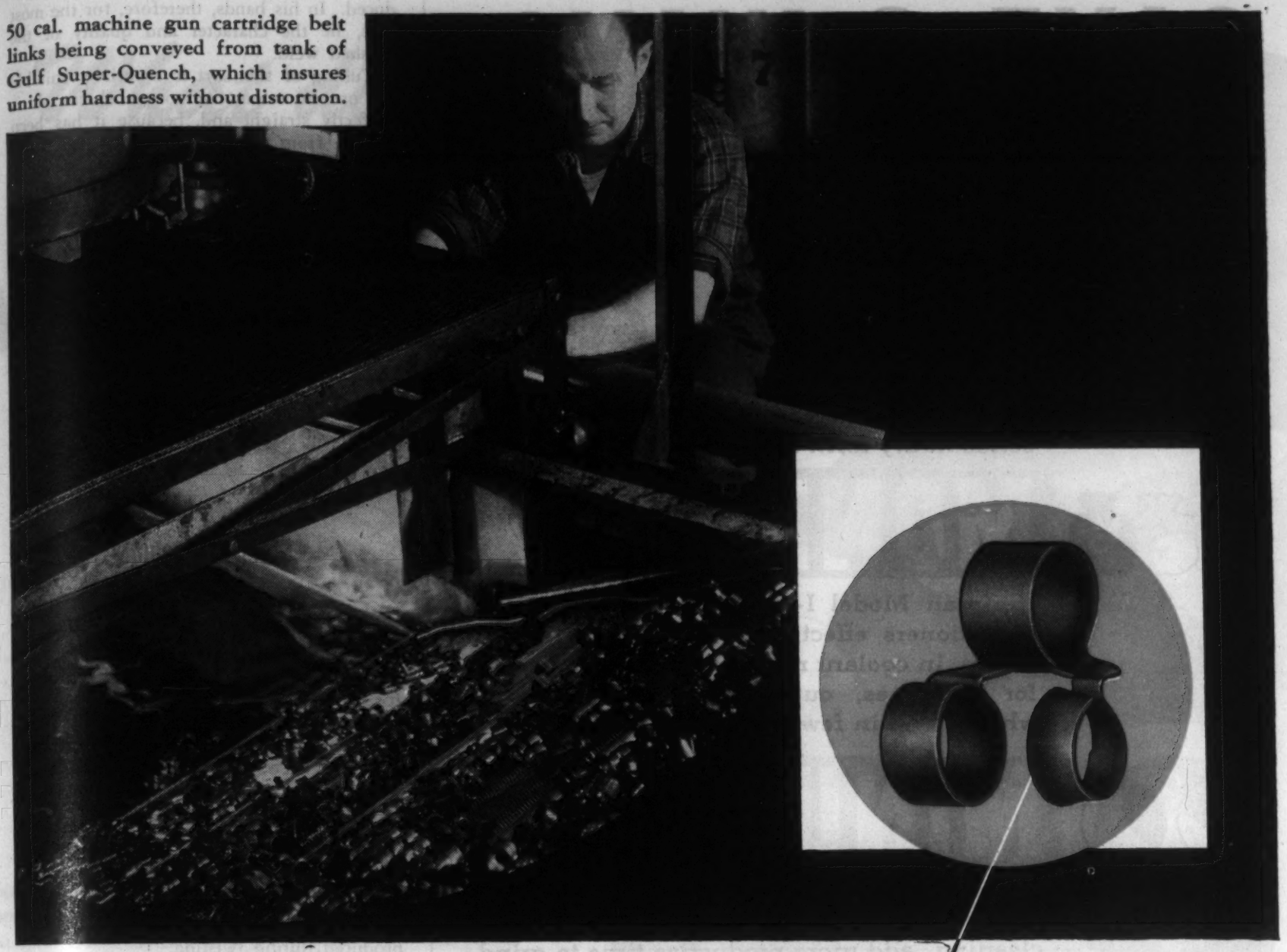
After previous experimentation with various methods, engineers have settled on oxy-acetylene welding. Today welds of the highest quality and strength are assured by a combination of factors in the gas-welding process. Most important among these are: A lengthwise puddle of molten metal; the surrounding of the puddle by an atmosphere that prevents oxidation; the maintenance of the puddle until all gases and impurities have escaped; and the compression of the plastic metal to produce a forging effect to refine the weld.

Almost any analysis of steel that is readily weldable by hand methods can be used satisfactorily for machine welding in the tube mill here described. Present specifications call for S.A.E. 1020 with a carbon content of about 0.20% and manganese as high as 0.60%. All steel purchased is silicon killed.

On the strength and structure of the weld more than on anything else depends the quality of the finished tubing. For this reason the welding unit is an extremely important item.

A two-torch continuous, graduated-heat unit with an 81-orifice tip is used. It is designed to provide for the most efficacious utilization of the flame characteristics of divers gas mixtures for preheating and welding, thus permitting higher welding speeds and reducing gas consumption. This is accomplished by gradual heating.

Throughout the welding stage, an experienced operator exercises threefold control over the procedure. Where any alteration in the procedure is called for, he can adjust the heat, position and gas pressure of the torches. These adjustments give him control over the quantity of edge metal melted, the length and breadth of the molten puddle and the cross-sectional area of the weld pro-



50 cal. machine gun cartridge belt links being conveyed from tank of Gulf Super-Quench, which insures uniform hardness without distortion.

## Another tough heat treating problem solved with

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## ... Cartridge belt link production increased 30%

***Revolutionary new quenching oil gives necessary loop tension without distortion, eliminates rejections, and reduces press down-time for die work 33%.***

Before Gulf Super-Quench was put in service in this plant, ordinary quenching oils wouldn't produce the necessary physicals and the proper tension to hold the 50 caliber cartridges with the required degree of firmness in the loops.

Here are the results with Gulf Super-Quench: Production of links increased 30%, rejections practically eliminated, and press down-time for reshaping dies reduced 33%—another one of many instances where this revolutionary new quenching oil has done an outstanding job.

Here's why Gulf Super-Quench is a superior quenching oil: It has intensified dual-action — a faster cooling rate through the hardening temperature range, and the slow speed of conventional quenching oil below the hardening temperature range. Call in a Gulf Service Engineer today and let him show you how Gulf Super-Quench can help improve your quenching practice. For a copy of the brochure on Gulf Super-Quench, send the coupon below.

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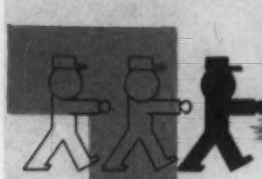
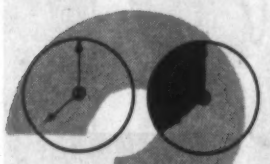


## 1 MEN

**A smaller maintenance crew can service a larger number of machine tools when Hoffman coolant conditioners are on the job. Hoffman filters continuously deliver waste solids in dry form for easy disposal.**

## 2 MONEY

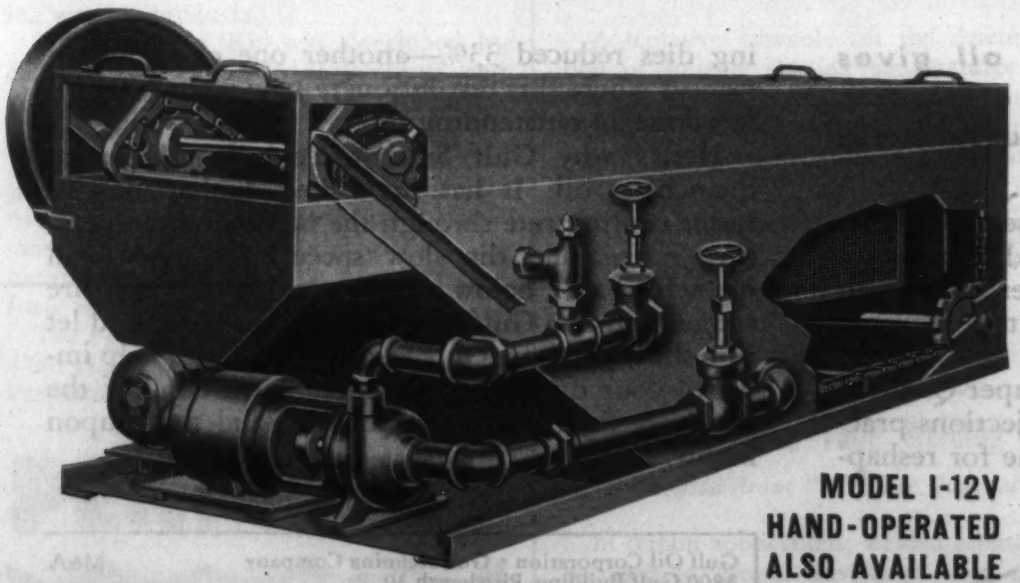
**Hoffman Model I-18V self-cleaning coolant conditioners effect large savings in maintenance, in coolant replacement, in longer life for machines, cutting tools and grinding wheels, and in fewer rejects.**



## 3 MINUTES

**'Round-the-clock operation becomes a reality. Hoffman filters eliminate shutdowns for sump cleaning, add more productive time to grinding machine operation, frequently permit faster operating speeds.**

## WITH HOFFMAN I-18V SELF-CLEANING COOLANT CONDITIONER



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duced. In his hands, therefore, for the most part, lie the character and quality of the finished weld.

Tubing of this sort is especially suitable for use in automotive torque shafts. It is perfectly straight and, because it has been formed from precisely measured flat strip, it is of absolutely uniform wall thickness. These two characteristics make it ideal for parts that will be required to rotate under a heavy load.

It has been impossible to find any recorded instance of a failure in the longitudinal weld area of a propeller shaft during the entire two years preceding June, 1942.

—G. C. Gridley. *Welding J.*, Vol. 23, Mar. 1944, pp. 217-224.

## Steel Forgeability

*Condensed from "The Iron Age"*

Data upon properties of steels above 1500 F. have been meager. Yet this information is valuable in establishing proper conditions for forming operations.

Work undertaken by Timken Roller Bearing Co. indicates that a definite relationship exists between hot twisting characteristics and forging temperature. This test seems to be more sensitive than other methods.

The apparatus consists of a furnace, a variable speed motor for turning the specimen at the desired rate, a chuck mounted in a bearing to which a torque arm is attached, and platform scales for measuring force produced during twisting.

Specimen size has been standardized at ⅝ in. round with material in the hot rolled condition, since at 1800 to 2500 F. initial heat treatment has little if any influence on results. Likewise for forging applications a rate of twist of 180 rev. per min. is used.

In each case the number of twists for fracture increases as the temperature is raised until a critical temperature is reached, after which the number of twists decreases. There are differences between the steels in (a) the number of twists required for fracture; (b) rate at which the number of twists increases with temperature; (c) temperature at which number of twists reaches a maximum; and (d) rate of decrease in number of required twists after the critical temperature is passed.

Metallographic examination of fractured twist specimens shows the cause of decrease in the required number of twists after a certain temperature is reached. As this temperature is exceeded, the nature of the failure changes in that intergranular cracking appears, even in sections removed from actual fracture.

The degree of cracking increases the higher the temperature is above critical, and this accounts for the resulting decrease in the number of twists.

Appearance of intergranular cracking at temperatures in excess of critical also explains the cause of certain defects in steel when forged at too high a temperature. While burning of steel is possible and the path of fracture is intergranular, distinction should be made between burnt steel and

# *What do you know about* WELDING STAINLESS STEEL?

Successful welding of Stainless Steel depends on (1) the type and characteristics of the steel to be welded, (2) the suitability of the electrodes used, and (3) *the skill and knowledge of the welder.*

The first two factors are constant because the production of stainless steel, today, has reached a high state of perfection and . . . *there is a type of* McKAY STAINLESS STEEL WELDING ELECTRODE, *with exactly correct characteristics,* for every stainless welding need.

The skill and knowledge of the welder, therefore, is of paramount importance! The more technical "know how" you have, the better.

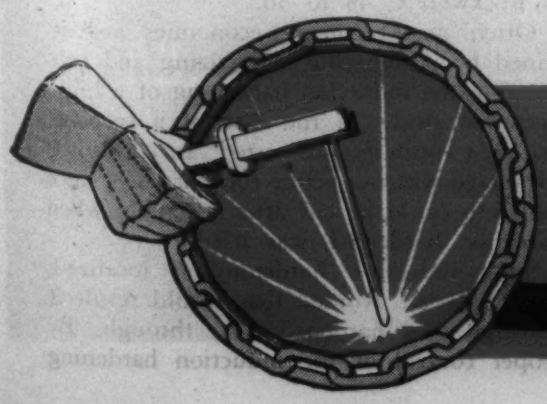
Can you answer the questions, listed at the right, correctly . . . and give the reasons for your answers? These and similar questions are discussed in a booklet soon to be released by the McKAY COMPANY. It will contain, as well, other data useful to every welder. It's *free.* Reserve your copy today by writing for *"Things to Know About Welding Stainless Steel."*

### DO YOU KNOW THE ANSWERS?

Test your knowledge with these 3 brain teasers. Then check the accuracy of your opinion by referring to the correct answers below. Space does not permit publication of the "reasons why" but full explanation may be found in the forthcoming McKAY booklet, "Things to Know About Welding Stainless Steel." Reserve your copy now . . . and watch for additional questions and answers in subsequent ads.

| | TRUE | FALSE |
|---|---|---|
| 1. *All Stainless Electrodes regardless of their manufacturing source or analyses, are coated with one or the other of two fundamental types of coating.* | ☐ | ☐ |
| 2. *Compared with ordinary steels, Stainless Steels of the Chrome-Nickel type conduct heat about one-half as rapidly and expand twice as much.* | ☐ | ☐ |
| 3. *Proper annealing practice for Chrome-Nickel Steels requires holding at 1900°F. for one hour for every inch of thickness; then furnace cool.* | ☐ | ☐ |

Answers: (1.) True (2.) True (3.) False



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steel forged at too high a temperature. In the first case damage occurs during the heating cycle and steel is permanently damaged, while defects due to forging occur during forging operation.

Deformation characteristics and the path of fracture is a function of temperature and rate of stress application. At room temperature deformation occurs primarily in the grains proper and the path of fracture is transcrystalline, while at 1000 F. and under very slow rate of deformation occurs.

While the rate of deformation is an important factor, it seems to lose its effect after a certain rate has been exceeded.

Hot twist tests are sufficiently sensitive to reveal: (1) Temperature that must not be exceeded in forging; (2) change of ductility of the steel with varying temperatures; and (3) change with temperature of the force required to deform steel.

As a matter of precaution, it is advisable to hold the maximum forging temperature 50 F. below the temperature at which greatest twist results.

—C. L. Clark. *Iron Age*, Vol. 153, Mar. 16, 1944, pp. 52-55.

## Design for Induction Heating

*Condensed from "Product Engineering"*

The possibility of applying rapidly and economically a uniform heat to localized areas by induction heating has simplified manufacturing processes and contributed to improved products. However, design modifications are often necessary to permit high frequency heating; as a rule, these modifications are only slight.

The only limitation to the application of induction heating is the possible difficulty or practical impossibility of making heating coils that will properly fit the part or the lack of powerful enough high frequency generators.

The design of the copper coil that carries the high frequency current is very important. It may consist of many turns or of a single turn. Its shape may vary widely, depending upon the shape of the material to be heated.

Various practical examples are given. If a thin surface is to be joined to a heavy one, overheating may result unless the design is changed by adding more metal to the thin section.

By suitable control, different parts of the same article may be hardened to different hardnesses. For example, in three operations on a gear, the cam surface is hardened to Rockwell C 60 to 62, the gear teeth to Rockwell C 53 to 55, and the clutch teeth to Rockwell C 48 to 50.

Often manufacturing economies are attained by eliminating carburizing and substituting the induction hardening of a higher-carbon steel. In the case of a sprocket that was formerly carburized, an additional advantage was the better concentricity, since the teeth could be cut after assembly when induction hardening was used.

Since induction hardening is localized, difficulties are avoided that would result if bearings were hardened clear through. By proper control of the induction hardening

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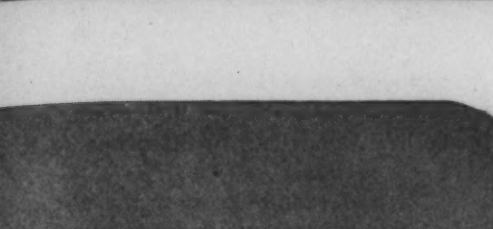
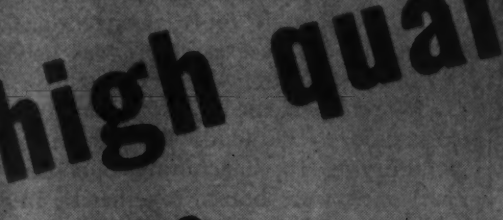
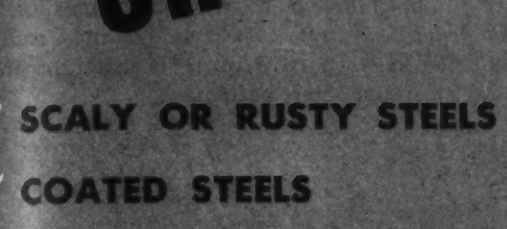


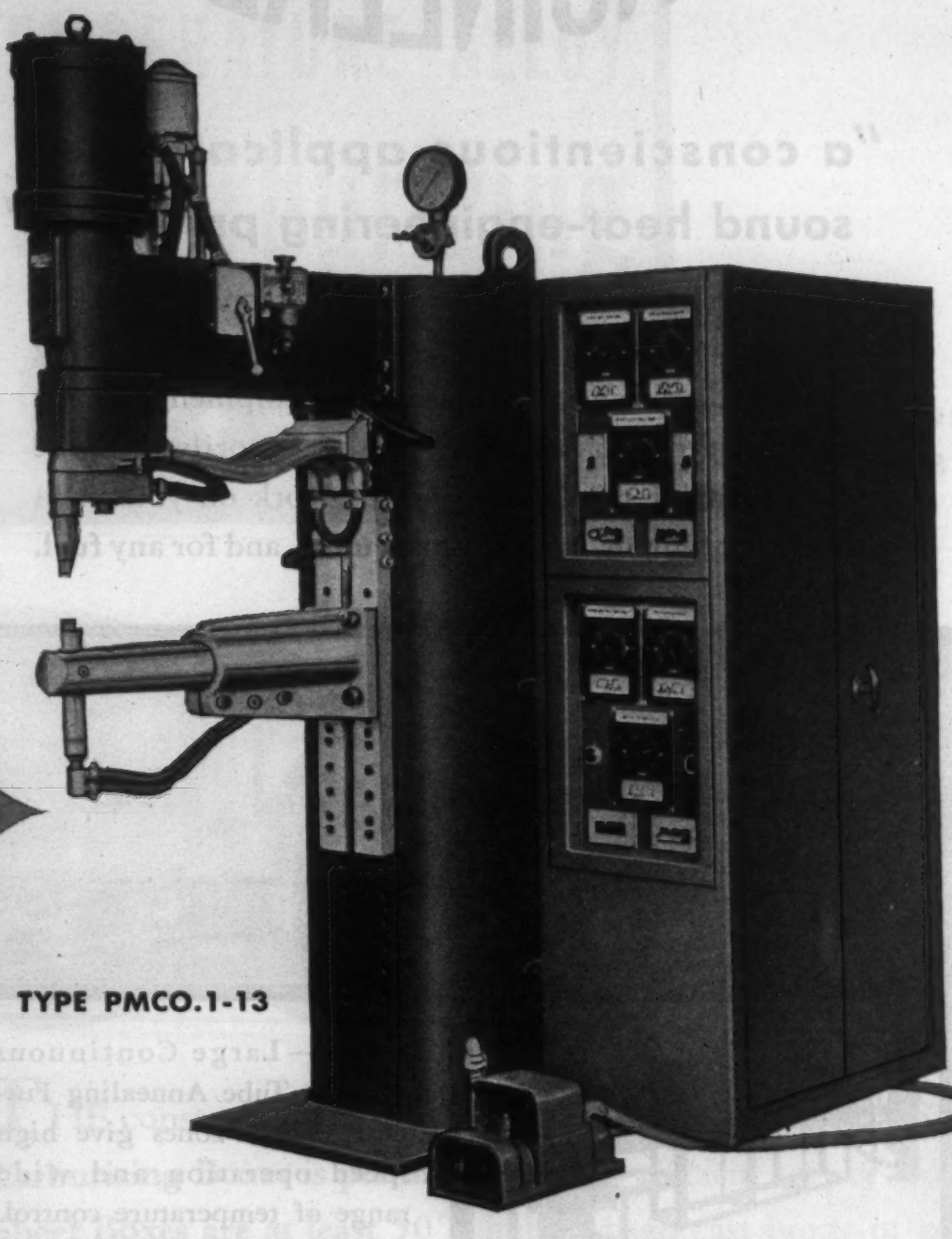

PREHEATING, WELDING AND ANNEALING CURRENT




VARIABLE PRESSURE




ADJUSTABLE QUENCH TIME



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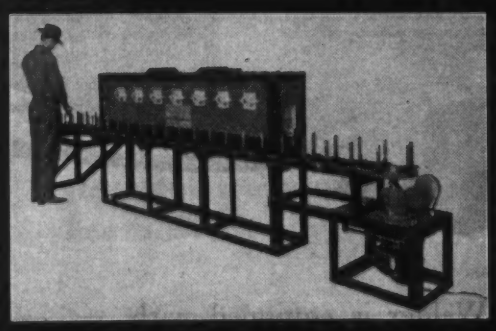
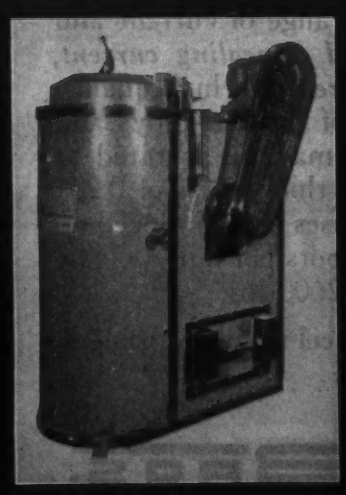


*Above*—Large Continuous Radiant Tube Annealing Furnace. Three zones give high speed operation and wide range of temperature control. Adjustment provided for variable speed.



*Left*—Small Continuous Gas-fired Silver Soldering Furnace designed to permit loading and unloading by a single operator.

*Below*—Small Batch-type Convection Heat-treating Furnace. This type of construction available in a wide range of sizes.

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cycle (through controlled timing), just the desired depth can be hardened to Rockwell C 62 to 64.

Several examples show the advantages of induction brazing. A flanged shaft formerly made by forging is now made of a bar and a stamping by induction brazing. A bevel gear was very difficult to machine when made as a single piece. Conventional brazing of a two-piece assembly was impossible, as it would soften the gear teeth.

Induction hardening and brazing enabled the gear to be made in two pieces, thus simplifying the machining operation. The two parts were brazed together by induction brazing, and the teeth subsequently hardened by induction hardening.

In addition to the advantages of rapid and uniform localized heating, induction hardened parts require no straightening or cleaning after hardening.

—F. W. Curtis. *Product Engineering*, Vol. 15, Apr. 1944, pp. 242-245.

## Plastic Tooling Speeds Production

*Condensed from "Machine Design"*

Experiments in plastic tooling have proved that: (1) Lacking the strength or mechanical durability of metal tools, plastic tools will serve only limited production; (2) they can be produced at an appreciably lower cost, and more quickly; (3) some types are now being used in regular production.

(4) Cast plastic tools are successfully adapted to low-stressed form or contour blocks, drill jigs, clamps for irregular shaped castings; and (5) flat plates, bolsters and spacer blocks are made from sheet forms.

Plaster of Paris, originally used, lacked sufficient strength. Improved forms, such as Hydrocal and Hydrostone, sacrifice ease of workability. Case phenol-formaldehyde tools and inorganic cements, such as magnesium oxychlorides, are used.

Hot - melt ethylcellulose compounds, Plastalloy and Thermocasts have proved of value in drop hammer dies. Being somewhat resilient, they yield without cracking. No allowance is made for metal thickness in casting these dies.

The low cost, availability and ease of manufacture of cast plastic tools will encourage their use, particularly for experimental work. The most important factor is the after, or service, shrinkage of the plastic. Their use does not necessitate major changes in design practice.

In hydropress work involving the forming of sheet metal, the reproduction of a cavity detail in cast plastic and the forming of the sheet metal by a thick rubber pad relieves stress concentrations. A steel shell or retaining ring extends the life of the plastic tooling.

The surface of the plastic can be finished quite smoothly, so as to require little or no further machining. Plastic punches will outlive lead punches and give cleaner, less noisy operation.

Double-acting presses are often used with advantage. In blanking and trimming operations, the actual shearing edges should be of tool steel.

# MISCO

## HIGH TEMPERATURE ALLOY Sheet Carburizing BOXES

Please turn to page 1377

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THE construction of Misco High Temperature Alloy Sheet Carburizing Boxes is planned for most efficient service. Misco Sheet Boxes are at least 50% lighter than cast boxes of equal capacity. Thermal stresses are reduced and pound for pound they last longer. Misco Sheet Boxes heat rapidly, save fuel, and reduce handling time. Based on our experience with thousands of carburizing boxes of all types, Misco Sheet Boxes afford maximum service per dollar of investment, and provide the greatest output in a given period of time . . . We will be pleased to furnish you with complete details regarding the many advantages of Misco Sheet Carburizing Boxes.

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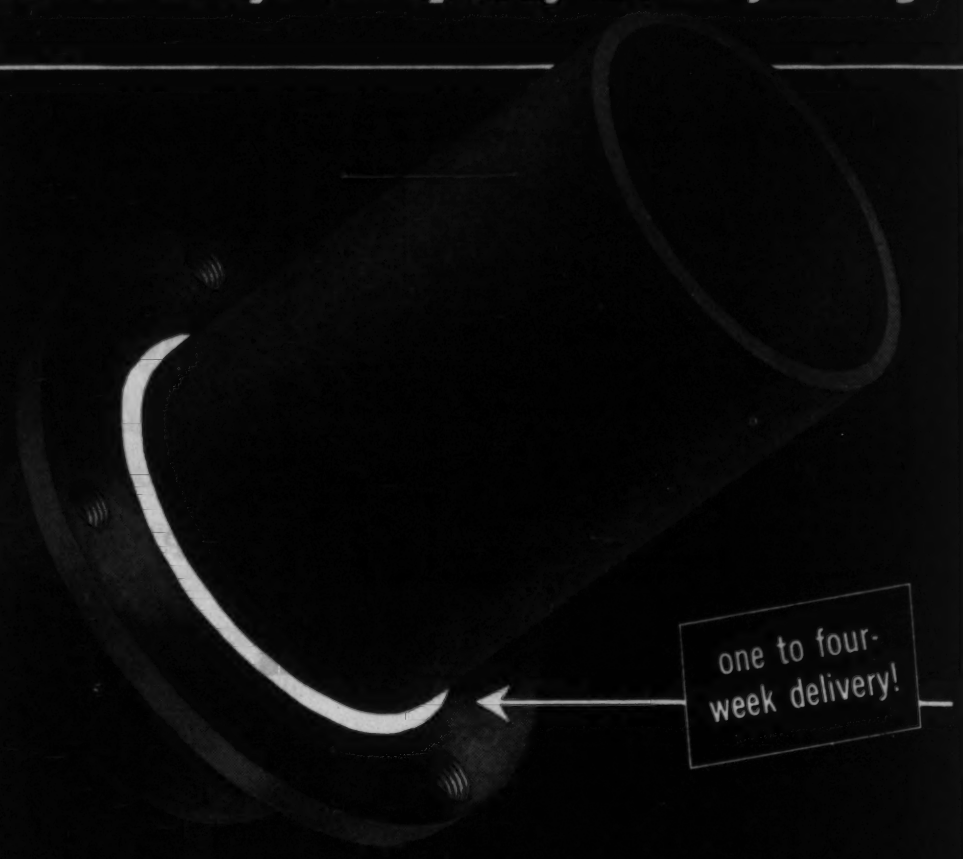


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- Saves man-hours–frees vital machine tools for other work.

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**NU-BRAZE GRADE III**—1300° F. silver-phosphorus brazing alloy with unique silver color that shows up against work—speeds production, minimizes rejects. Multiple-annealed to eliminate brittleness and permit easy winding and shaping.

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Plastic castings for molding irregularly shaped forms to be mounted in a lathe or chuck, and cast forms for routing jigs are superior to any machined form used in the past. Cast resin injection molds, assembled with metal supporting blocks, are of low cost and suitable for experimental moldings.

Already giving increased production and lower tooling costs, cast plastics will be most important in the production of experimental models for designers.

—J. Delmonte. *Machine Design*, Vol. 16, Mar. 1944, pp. 99-103

## Silver Brazing Fluxes

*Condensed from "Steel"*

Fluxes used for silver soldering have four general functions: To dissolve oxides formed from the parts being joined and from the brazing alloy; to shield the brazing alloy and joint from oxygen; to aid flow of brazing alloy by capillarity; and to provide chemically clean metallic surface for the melting and spreading of the alloy.

There are four types of fluxes: (1) Dry powdered, 10 to 60 mesh particle size, for torch brazing to protect the brazing alloy if metal additions are made in wire or rod form. They are used also in furnace and resistance brazing.

(2) Paste flux, most universally used, for torch, induction, furnace resistance and incandescent carbon brazing. They contain 10 to 30% water, with solids under 40 mesh. (3) Saturated solution, resembling the paste, heated to 160 F. upon using, applied by dipping, spraying or brushing.

(4) Volatile fluxes, for brazing where a brazing torch is used. The compounds decompose and yield boric oxide as chief fluxing agent. Chemicals in all four are about identical, varying in degree of hydration.

Compositions are usually combinations of several chemicals, including borates, carbonates, chlorides, phosphates, and fluorides of sodium, potassium, calcium, lithium, strontium and zinc. A volatile brazing flux is an azeotropic mixture of a distillable alkyl borate and a volatile organic solvent that forms a constant boiling mixture with the borate.

Fluxes of the powdered, paste and saturated-solution types melt at 800 to 1100 F., and are persistent to 1600 to 1700 F.

### To Clean Metal Surface

Most commercial fluxes contain salts of lithium, sodium and potassium, the last being best because of their chemical activity and lower melting points. Moreover, sodium fluxes emit a yellow flame that results in poor visibility.

One of the most efficient methods of removing oily films preparatory to operations is by solvent degreasing, using, say, a

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You've waited for this — electrodes that perform equally well on AC or DC! They're ready — not one, but *two* such electrodes — to simplify buying — to save your time and money with an arc that's extremely stable and easily controlled. Thoroughly proved in use and by exhaustive tests, these electrodes are ready to serve you better. Prove them to yourself *now* with a trial order.

### AC-1
**E-6010 and E-6011**

For AC, and either polarity on DC

Tensile strength, 65,000 — 70,000 P. S. I.
Yield, 55,000 — 60,000 P. S. I.
Ductility, (2") — 25% to 35%.
Available in all sizes — 14" and 18" lengths.

*Conforms to requirements of:*

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### AC-3
**E-6012 and E-6013**

For AC, and either polarity on DC

Tensile strength, 65,000 — 70,000 P. S. I.
Yield, 55,000 — 60,000 P. S. I.
Ductility, (2") — 18% to 25%.
Available in all sizes — 14" and 18" lengths.

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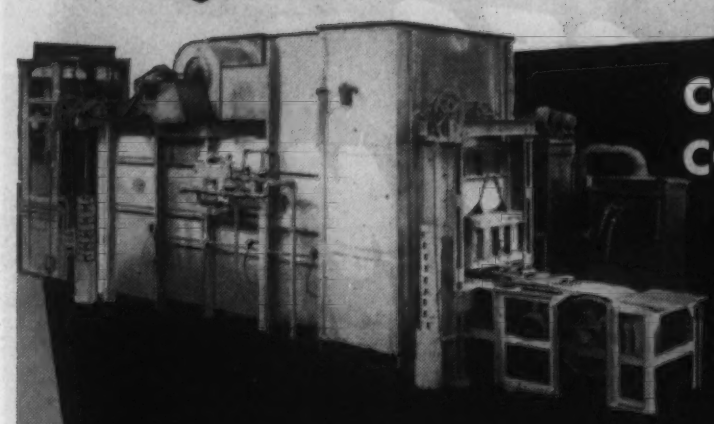


CONTINUOUS CONVECTION FURNACES

A TYPICAL example of R-S thoroughness in adapting a type of furnace to a particular heat-treating job is the continuous convection, gas-fired furnace illustrated above. Frankly, we are not permitted to divulge full details. Suffice it to say that the production results substantiate our claims of exceptionally uniform and close temperature control (400 to 1300°F.), general over-all efficiency, automatic operation and minimum labor to load and unload. Parts are loaded on the wire mesh belt which moves at a constant, set speed, variable at will.

From the viewpoints of delivery, efficiency in operation and reliability, the R-S Furnace record is truly outstanding. It justifies the use of the expression "Furnaces of Distinction."

FURNACE DIVISION

**R-S Products Corporation**

4522 Germantown Ave., Philadelphia 44, Penna.

FORGING • PLATE AND ANGLE HEATING • CAR HEARTH
METAL MELTING • CONVECTION • ROTARY HEARTH
ANNEALING • CONTINUOUS CONVEYOR • SALT BATH

R-S Furnaces of Distinction

BUY WAR BONDS


stabilized trichlorethylene. Another way after machining or pressing is by alkali degreasing.

Wire brushing, filing, grinding, sand blasting, pickling and electrolytic etching are also used. Some manufacturers add a wetting agent to aid thorough application of flux.

Fluxes applied to ferrous metal parts should have a pH of 8 to 10, as this prevents corrosion of parts if they stand a considerable time prior to brazing. For tight fit joints, actually press fits, the saturated-solution fluxes are best.

Two of the most important properties of a silver soldering flux in the molten state are its surface tension and its solvent capacity for oxides at the temperature where the brazing alloy flows.

One of the standard government inspection tests for these fluxes is the persistence in the liquid state at 1600 F., and it should remain liquid as low as 1150 F., with some commercial fluxes actually accomplishing 650 F.

—H. L. Anthony. *Steel*, Vol. 114, Mar. 13, 1944. pp. 94-96, 134, 136.

## Precleaning With Solvent Emulsions

*Condensed from "Monthly Review," American Electroplaters' Society*

Recent innovations in slushing, cutting and stamping oils, anti-rust materials, etc., have complicated the job to be done by a cleaner. For example, complex organic compounds that combine chemically with the metal surface are added to cutting oils. Synthetic resins are used in binding abrasives. Paraffinic type materials are being more commonly used in all metal processing compositions.

In each of these cases, cleaning with hot alkali cleaners alone is slow or incomplete. Solvent emulsion precleaning will help in removing such materials. Three methods of application are used:

(1) The work is sprayed or dipped or otherwise contacted with the cleaner, without addition of water. After ½ to 3 min. contact at room temperature, with moderate agitation, the work is rinsed with water, preferably hot. A milky emulsion is formed on rinsing, the major part of the cleaning occurring at this time.

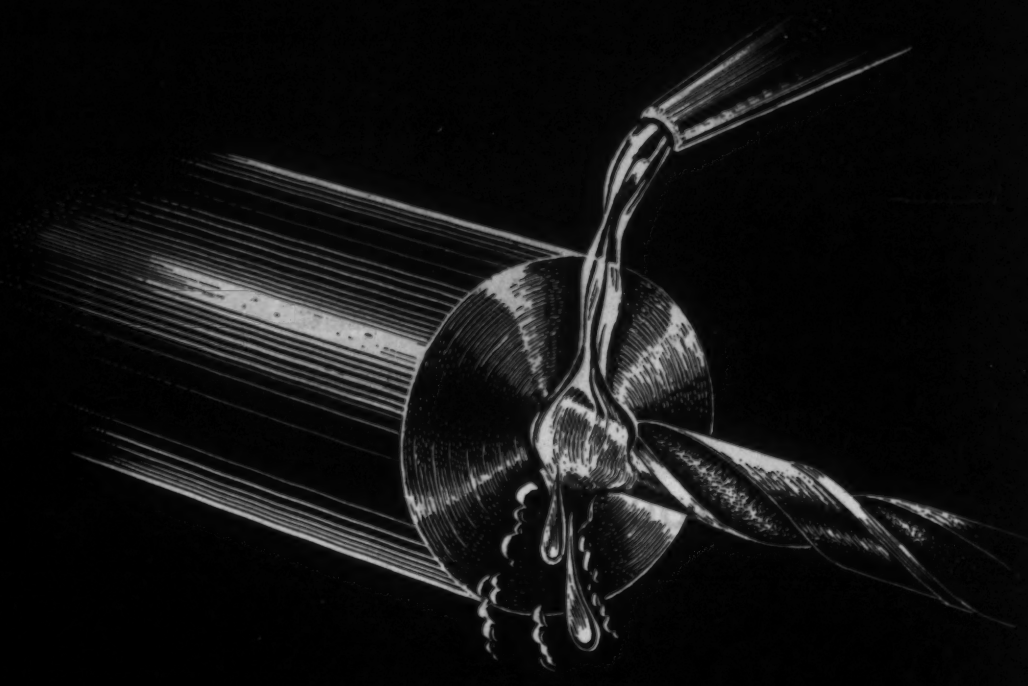
A slight film of the solvent remains on the work, which must be removed by 20 to 30 sec. electrolytic alkaline cleaning. The useful life of a dip bath used with this method is very long, particularly if provision is made for sludge removal.

(2) The diluted cleaner is mixed with water to form an emulsion and applied to the work in a pressure spray washing machine. Temperatures of 140 to 190 F. are usually used. Water dilutions with from 50 to 100 parts water are probably most useful.

(3) The water emulsion may be used in a soak tank, with or without the addition of alkali. High temperatures are desirable. This is the least effective method of application.

Three types of soiled surfaces useful for laboratory tests for evaluating cleaners

# EXAMPLE OF *Service*:



*"How to reduce tool wear in drilling operations?"*. . . A manufacturer put this problem to a Cities Service Lubrication Engineer. Our engineer surveyed operations . . . recommended a special *transparent* blend of Cities Service Cutting Oil . . . *increased tool life by 25%.*

For another "Example of Service" write for *your* free copy of METAL CUTTING FLUIDS—26 pages of helpful information. Address: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

**More and more, it's service that counts . . .**

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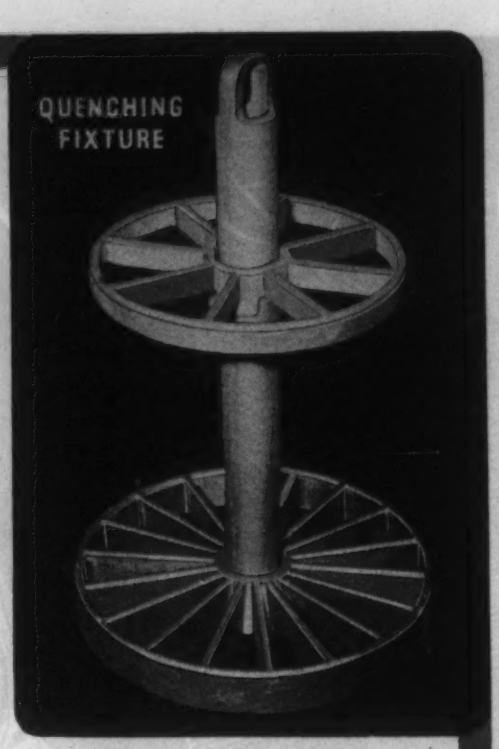


*The*
**REASON WHY**
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**has been picked to execute some outstanding high temperature alloy installations is that we conscientiously apply**

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**to every job and that we have the necessary personnel, willing and experienced at their tasks. The result is dependable production and product performance.**

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|---|---|---|---|
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| " 2 | 60.0 | 12.0 | Boxes — Retorts — Chain — Fur- |
| " 3 | 38.0 | 18.0 | nace Parts—Baskets—Convey- |
| " 4 | 35.0 | 15.0 | ors—Hearth Plates—Skid Rails |
| " 5 | 9.0 | 29.0 | —Solution Pots—Anything to |
| " 6 | 12.0 | 25.0 | operate between 1000°F and |
| " 7 | 20.0 | 25.0 | 2000°F.* |
| " 8 | 10.0 | 28.0 | **Under certain conditions this* |
| " 9 | 3.0 | 28.0 | *temperature may be exceeded* |
| " 10 | 8.0 | 18.0 | *with successful results.* |

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are described: (1) Corrugated aluminum panels are smeared with a paste of lubricating oil and talcum powder, and baked at 300 F. for 3 hr.

(2) Ground glass plates are soiled by rubbing dry carbon black of 28 millimicron particle size into the surface with a spatula; and (3) cold-rolled steel panels are soiled on a buffing wheel with the composition under test.

The action of a solvent emulsion cleaner is compared to first washing the hands with a low viscosity oil, and then with soap. The solvent oil dissolves the grease and lowers its viscosity.

In an analogous manner, solvent emulsions take the "cling" out of the soil, leaving them coated with soap and in a condition such that the rinse readily carries them away. Since only a very thin solvent film remains on the work, only a light alkaline cleaning is necessary after the emulsion treatment. This results in a long life for the alkaline cleaner.

The method has some advantages over the use of vapor degreasing, in that after vapor degreasing, solid particles that are present remain on the work. Operating costs, aside from solvent replacements, are much less, since no cooling water and no steam (in the dip method) are required.

The concentrate can be prepared with any degree of alkalinity, making possible the treatment of easily etched metals. In the case of zinc-base die castings, *e.g.*, the time in the alkaline cleaner is reduced to such a short period that there is almost no attack of the zinc by the cleaner.

—C. S. Lowe. *Mo. Rev.*, Am. Electroplaters' Soc., Vol. 31, Jan. 1944, pp. 29-40.

## Radiant Gas Heat for Drying

*Condensed from "Proceedings," American Electroplaters' Society*

Radiant heat for baking organic finishes or for curing and drying operations can be obtained from suitably designed gas burners as well as from electric lamps. In the gas burners, the flame is directed along a ceramic surface that is heated to incandescence. Incandescence, both in the case of infra-red electric lamps and gas burners, is incidental.

The infra-red rays, which are largely effective in baking processes, are invisible, but practical production of infra-red rays always includes production of some visible rays. Any form of commercial gas may be used in these burners.

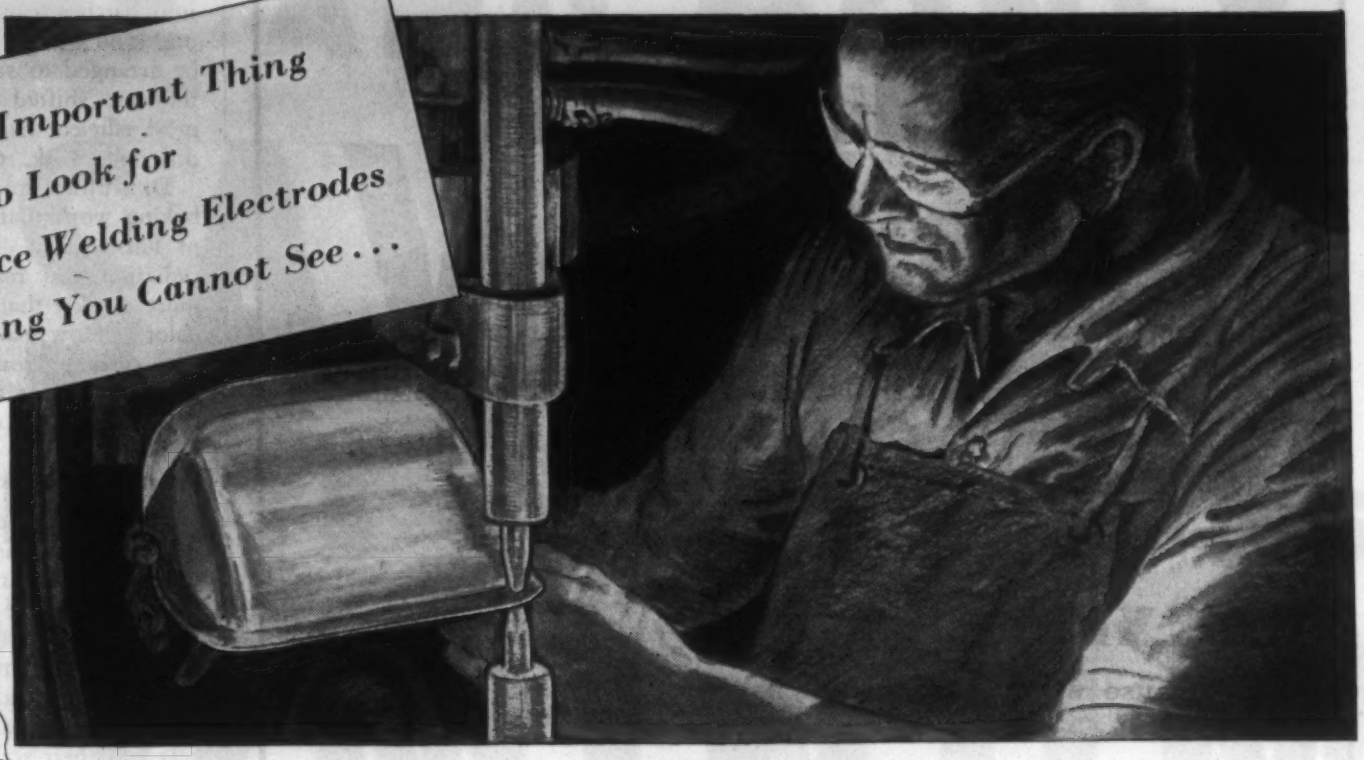
Several standard forms and shapes of the ceramic material are available, but special forms may be designed and built for new applications.

In designing an installation, the burners should be placed in such a position with respect to the work that the rays are directed toward the work. If an oven is used for only one kind of work, this can usually be readily accomplished.

If several kinds of pieces of different sizes and shapes are baked in the same

(*Continued on page* 1498)

The Most Important Thing
To Look for
in Resistance Welding Electrodes
is Something You Cannot See . . .



# Mallory Experience . . .

## *Unseen Element Behind the Latest Advancements*

*New Mallory Heavy-Duty Holder:* Streamlined, tough, with single piece housing to protect vital inner parts and eliminate leakage troubles. Tip is quickly ejected by hammer blow at opposite end.

Every resistance welding electrode, holder, casting or forging of a Mallory alloy incorporates definite, carefully controlled physical and electrical advantages. Behind these advancements is an invisible element —the plus factor of Mallory experience.

Mallory experience, for instance, formulated Mallory 3 Metal for welding cold-rolled steel faster, more soundly and at lower cost . . . tough Elkonite*, with its extreme hardness for electrical upsetting. Mallory's recommendations on size, construction and contour of electrodes represent accumulated studies dating back to the early days of resistance welding.

Not only does Mallory have electrodes of correct properties for wide and varied industrial requirements, but it places at your service engineering skill to solve unusual and baffling problems. Write Mallory for specific recommendations on how to speed production, cut down welding costs, with better electrodes for spot, seam, flash or projection welding.

*Elkonite is the registered trademark of P. R. Mallory & Co., Inc., for refractory metal compositions

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*— Buy More War Bonds*

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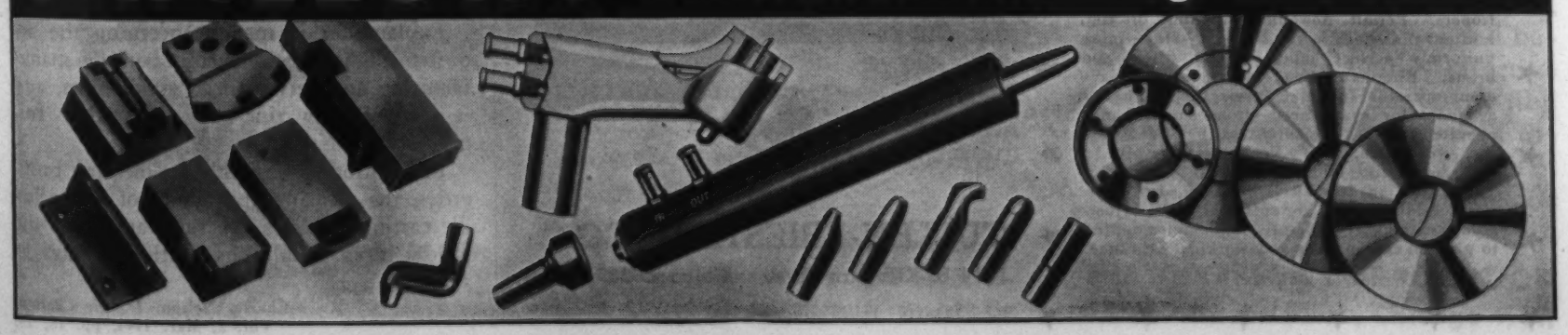
MALLORY Standardized Resistance Welding Electrodes



# SILVER

## BRAZING ALLOYS:

"Readyflow"—56% Silver—works at 1165 deg.

B 201 —20% Silver—works at 1485 deg.

Also many other standard and special compositions.

## ANODES:

Of all desired dimensions.

## FLUXES:

For use with Silver Brazing Alloys.

*Write for booklet "MA"*

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EST. AW 1875


oven, it may be best to sort the pieces into batches, each batch having in it only one kind of work. The burners can then be arranged to suit one batch, after which they are shifted to new positions to give most efficient baking of a second batch of different work, etc.

Difficulties are sometimes experienced in baking work that has more than one color of finish on it. Black, *e.g.* absorbs more radiation and reaches a high temperature more quickly than a lighter, more reflective color. Slow baking may be required in such cases. About 20% more time may be required to cure a finish on a polished surface than on an unpolished surface.

### Distance Important

The distance between the work piece and the heat source is of great importance. An increase in distance from 6 in. to 10 in. may increase the curing time as much as 500%. This factor must be taken into account in designing equipment.

If radiant heat ovens are designed so that convection and hot combustion products add their action to the radiant energy, the production output per unit of floor space will be higher than for any other type of oven.

In infra-red lamp installations, baking temperatures in excess of 600 F. are not practical. This eliminates lamps from consideration in applications such as baking of vitreous enamels. Radiant gas burners are well suited in the latter application.

From the standpoint of equipment cost, infra-red lamps are cheapest, radiant gas burners next, and convection ovens are most expensive.

Radiant gas burners are being used in many applications other than baking finishes, such as drying lithographed finishes on metal, drying plaster molds, drying printing inks on high-speed presses, sealing paper milk bottles, baking food, treating textiles, setting etching resists in photoengraving, baking fluorescent lamp coatings at 1400 F., and in heat-flowing electrolytic tin plate on strip tinning lines to give a bright, less porous plate.

—Carl P. Mann. *Proc.*, Am. Electroplaters' Soc., 1943, pp. 68-73


# C-F POSITIONERS

## Faster, Better, Safer Welding

And more economical too, with C-F Positioners. Permit downhand welding of top, bottom and sides with a single setup—more uniformly perfect joints, better fillets and beads. Eliminate frequent crane-lifts, save crane-operator and sling crew time. There's a model for every need—from small, hand-operated types to giants that handle 30,000 lbs. weldments. C-F Positioners revolve a full 360°, tilt to 135° beyond horizontal. Table rotation from 0 R.P.M. up, for automatic welding. They are universal tools, adjustable for height—pedestal or boom mounted to give maximum floor and working clearance.

*Write for Bulletin WP-22*

CULLEN-FRIESTEDT CO.

1314 S. Kilbourn Ave. Chicago 23, Ill.


## Die Cast Bearing Components

*Condensed from "Die Casting"*

Close dimensional tolerance, light weight, and adaptability to high-speed production are characteristic of zinc alloy die castings that make them particularly suitable for ball-bearing retainers operating below 150 F. and housings for light duty pillow blocks.

Explanation is made concerning the requirements for retainers from both the manufacturing and service need standpoints, and it is shown how zinc alloy die castings fulfill such needs.

In addition to desirable engineering properties, the pleasing appearance of zinc alloy die castings adds to the sales appeal of the pillow blocks, and thus of the bearings as a whole.

—Charles Nelson, Jr. *Die Casting*, Vol. 2, Mar. 1944, pp. 18, 19.

# TIME AND MONEY SAVING PRODUCTS FOR PREPARING ALUMINUM FOR PAINTING AND ANODIZING

## DEVELOPED BY DIVERSEY

**HELP WANTED!**

Here's one "help wanted" problem that's easily solved . . . even in these days of man-power shortages. If it's a problem in metal cleaning and working . . . the Diversey D-Man is always on deck to lend a helping hand. Backed by a Research Laboratory that has spent 18 years developing special purpose products, the Diversey D-Man can often show you ways to step-up production that require less man-power.

**Simple Cleaning**—For cleaning aluminum prior to painting or anodizing, the Diversey Research Laboratories have made available four different products, each with specific properties to meet varying requirements and conditions. They include Diversey Aluminum Cleaner, S S Aluminum Cleaner, Diversey D-C No. 36 and D-C No. 38.

At the moment Diversey D-C No. 36 is perhaps the most popular. Recently markings on aluminum sheets have been changed and these new markings have been quite a problem with ordinary cleaners. D-C No. 36 not only removes such markings completely but does the job in about one-fifth the time ordinarily required.

**Anodizing—Electrolytic Process**—Prior to anodizing by the electrolytic process, aluminum must be thoroughly cleaned. For this purpose, the four products mentioned above are recommended. In each, powerful cleaning action is supported by unusual wetting and emulsifying properties which quickly and completely removes oil and grease. At the same time, special inhibitors prevent pitting, staining or discoloring of the aluminum surface.

**Anodizing—Non-Electrolytic Process**—In this process, pre-cleaning is also essential. For this purpose, D-C No. 36 is particularly recommended because of its unusually effective free-rinsing action. It leaves no film on the surface to interfere with the subsequent successful completion of the operation. For further details write Metal Industries Department.

**THE DIVERSEY CORPORATION**
**53 W. Jackson Blvd., Chicago 4, Ill.**

# 4 Materials and Engineering Design

*Engineering Properties of Metals and Alloys • Resistance to Corrosion, Wear, Fatigue, Creep, etc. • Engineering Design Problems of Specific Industries and Products • Selection of Metals, Metal-Forms and Fabricating Methods • Non-Metallics in the Metal Industries • Applications of Individual Materials • Conservation and Substitution*

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*Precision Bearings of Glass* ——— 1500

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*Improved Lead Bearing Alloys* ——— 1512


## Plastic Nameplates

*Condensed from "Machine Design"*

Plastics are replacing critical metals for name plates, instruction plates, data plates and dials. Distinction is made in limitation orders between nameplates and utility plates, such as instruction and data plates. Restrictions concern chiefly the thermoplastic types. Nameplates may utilize phenolics such as aldehyde types.

Plates from etched or printed thermoplastics, such as cellulose acetate or vinyl sheets, and those using certain plasticized thermoplastics, such as urea-melamine resins, are readily blanked, punched, or sheared.

Common processes used include etching, embossing, molding, engraving and printing. With the exception of printing, they are usually filled in with colors.

Laminated sheet, having the top lamination in color contrast to the core, may be etched to give either an engraved or an embossed effect.

Molded plates, especially thermoplastics, may be produced economically in large quantities. Clear or translucent plastics with modern back lighting make excellent plates. They usually have characters depressed from the reverse side and color filled.

Where details are not intricate and the relief small, embossing may be used. Engraving is employed for accurate detail and for limited quantity production.

**Clear Resin Over Printed Sheet**

Printed phenolic or urea plastic plates are produced by using a printed sheet, covered by clear resin, as the top lamination. Silk-screen and photographic processes are similarly employed. Such plates will withstand heat up to 275 F. They have the approval of all war agencies.

Double-shot molding permits the use of one color as an insert for the molding of the second. Special equipment provides for simultaneous inking and indenting of printed detail into phenolic, urea or thermoplastic surfaces.

Extruded cellulose acetate and extruded cellulose acetate-butyrate are available in any color and degree of translucence. Cellulose acetate becomes brittle at low temperatures, expands and absorbs 7% moisture. The butyrate is preferable because of its greater dimensional stability.

Cellulose nitrate is tougher than cellulose acetate, and more available. It burns at a higher rate, but the burning qualities are not pronounced when fastened on a metal surface.

Polyvinyls are non-flammable, have dimensional stability and are tough. It is difficult to obtain allocation for them except for small orders.

None of the available plastics combines the advantages of metal, such as fire-resistance, ductility, formability, and good stamping properties. They do, however, offer certain advantages, such as light weight, salt water resistance, insulating properties and immunity to acids, alkalis or oxidizing agents.

—J. W. Greve. *Machine Design*, Vol. 16, Mar. 1944, pp. 112-114.

## Precision Bearings of Glass

*Condensed from "Product Engineering"*

Development of glass ring-jewel bearings to meet all the rigorous requirements of aircraft instruments emerges as another important example of American accomplishment in wartime. Glass bearings meet low friction requirements, withstand vibration, wear and shock conditions imposed by aircraft service, and are comparable to sapphire jewel bearings.

The general requirements of a substitute bearing process to suit the situation were listed briefly as:

(1) The process must be capable of producing on a mass-production basis from the hardest material available bearings that would meet the rigid requirements for aircraft instruments.

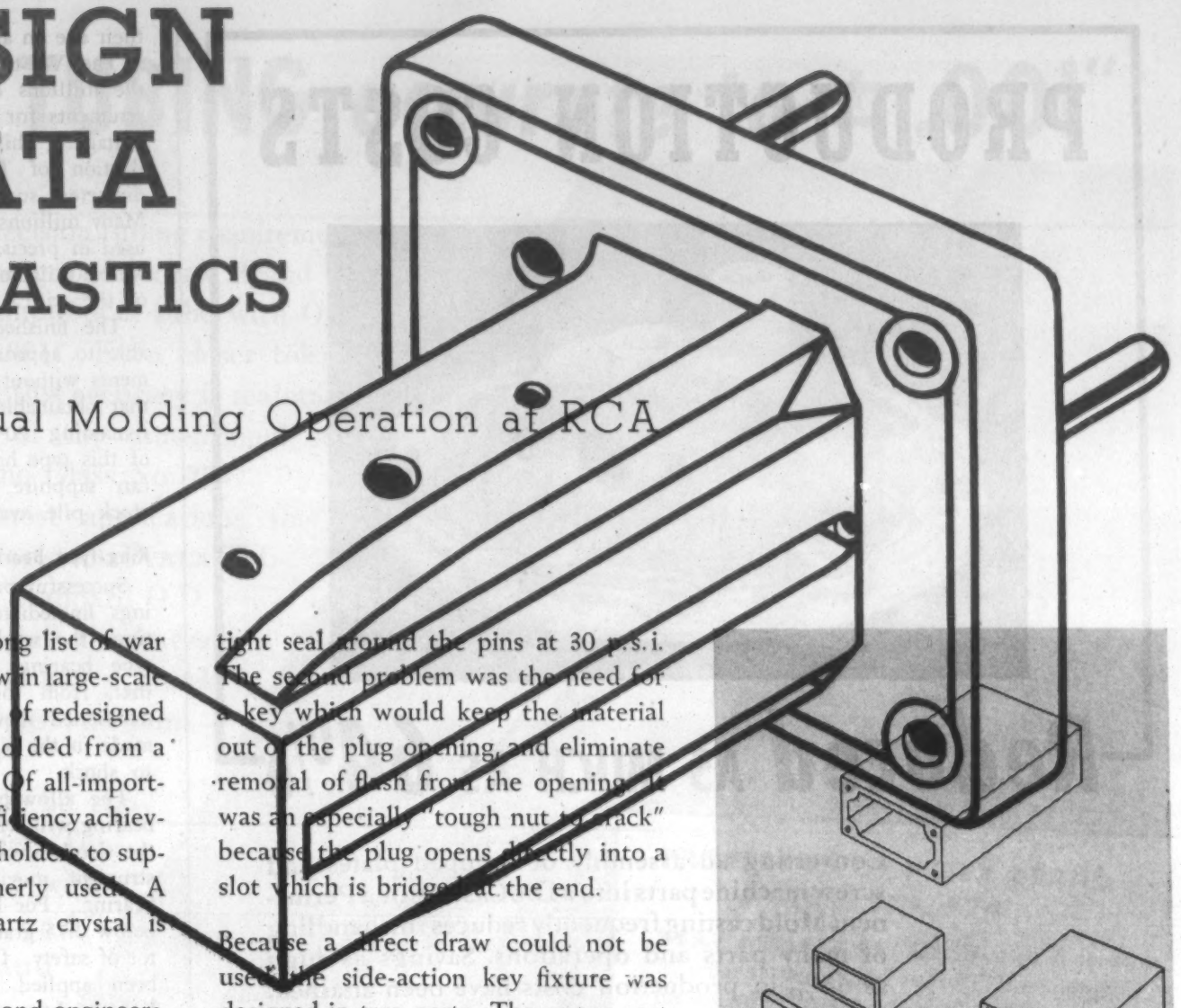
(2) The friction in combination with steel should be as low and as uniform as possible, comparable to sapphire.

(3) The bearings should be able to withstand impact and shock loads comparable with those taken by sapphire bearings, or at least adequate for the particular application.

(4) The bearings should have a life comparable to sapphire bearings under shock and vibration conditions imposed by

# DESIGN DATA ON PLASTICS

## VI. An Unusual Molding Operation at RCA

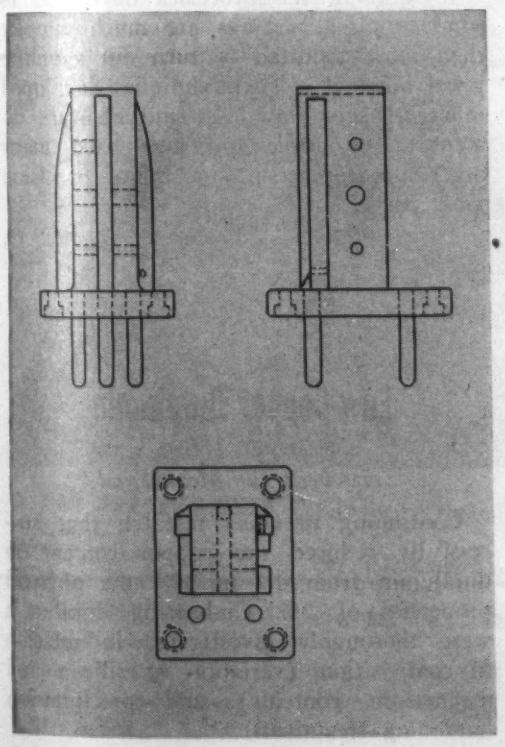


Adding another to its long list of war contributions, RCA is now in large-scale production with a series of redesigned crystal holders—all molded from a Durez phenolic plastic. Of all-important interest is the new efficiency achieved, which permits small holders to supplant larger sizes formerly used. A saving of 50% in quartz crystal is being realized.

Of interest to designers and engineers, however, is the ingenuity which RCA has put into the job. In designing the molds two major problems became evident. RCA engineers wanted a water-tight seal around the pins at 30 p.s.i. The second problem was the need for a key which would keep the material out of the plug opening, and eliminate removal of flash from the opening. It was an especially "tough nut to crack" because the plug opens directly into a slot which is bridged at the end.

Because a direct draw could not be used, the side-action key fixture was designed in two parts. The upper part is removed by a straight sideway motion, and the lower half is removed by a slightly upward and then sideway motion.

This molding achievement has been accomplished with a Durez phenolic plastic—added evidence of the outstanding moldability of Durez, and added proof of the familiar Durez line "Plastics That Fit the Job." In the production of hundreds of current items, it has been found that the moldability and versatility of Durez compounds contained the ideal answer.



We welcome the chance to discuss the advantages of Durez plastics for your needs. As one of the oldest and most experienced producers of phenolics, our laboratories and technical staffs are often able to make valuable suggestions.

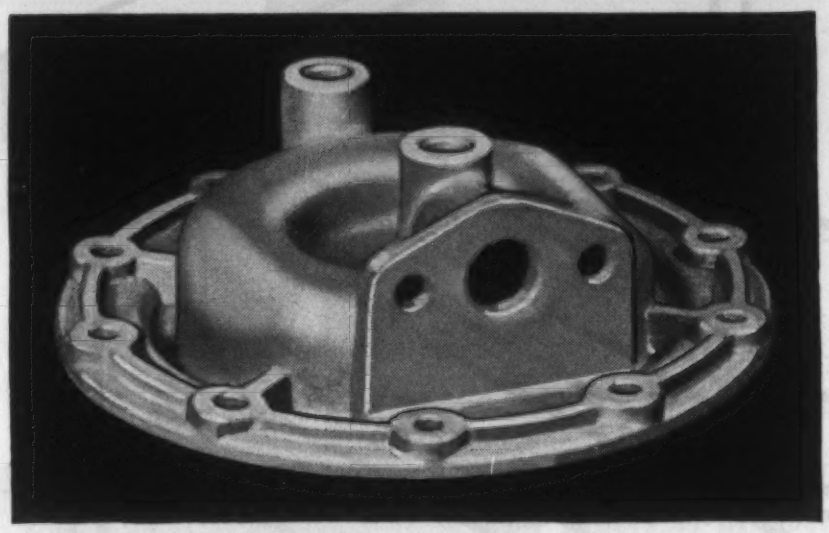
Durez Plastics & Chemicals, Inc., 96 Walck Road, North Tonawanda, New York.

DUREZ

PHENOLIC MOLDING COMPOUNDS AND RESINS

**PLASTICS THAT FIT THE JOB**

# PRODUCTION COSTS



## Reduced AS MUCH AS 64%

Converting an assembly of stamped plates and screw machine parts into a Die Casting or a Permanent Mold casting frequently reduces the handling of many parts and operations. Savings as high as 64% in production costs have been attained.

**FACTS ABOUT ZINC IN ZINC DIE CASTING:**

The alloys used with Zinc for specific results are, aluminum, copper and magnesium. The total of these will average 5.37% of the content of the metal.

Tensile Strength ranges from 40,300 to 47,900 pounds per square inch. Elongation ranges from 3 to 5% in 2 inches. Compression Strength, 60,500 to 93,100 pounds per square inch. Brinell Hardness 74 to 83. Specific Gravity, 6.7. Weight, pound per cubic inch, 0.24. Melting point, 715 degrees Fahrenheit. Maximum weight of casting, 16 pounds. Minimum wall thickness, large castings, 0.05; small castings, 0.02 inch. Cast threads, maximum number per inch, external 24, internal 24. Cored holes, minimum diameter, 0.031 inch.

Next month we will feature data on aluminum.

We are now preparing a Booklet "CASTINGS —Aluminum & Zinc". This is a practical treatise on the application of Zinc in Die Casting and Aluminum in sand casting, permanent mold and die casting. A card will bring this Booklet to you, gratis, as soon as it is off the press.

Let Monarch's 30 years experience with nonferreous metals help you with your design and production problems. Complete facilities for testing, heat treating, machining, grinding, buffing, inspection, and assembly.

**MONARCH ALUMINUM MFG. COMPANY**

*General Offices and Plant:*

**9235 DETROIT AVENUE • CLEVELAND 2, OHIO**


their use on an aircraft instrument panel.

The Vee-type bearing was required for the millions of small panel electrical instruments for measurement of current and voltage. This need was met by the production of hard glass bearings having diameters such as 0.051 in. and 0.076 in. Many millions of these bearings have been used in precision military instruments, and were available practically at the beginning of the critical production period.

The finished glass bearing was applicable to approximately 80% of the instruments without sacrificing performance over that obtainable with sapphire jewels. The remaining 20% of the required jewels of this type have been supplied by American sapphire production, and from the stock pile available.

**Ring-type Bearings Required**

Successful production of glass Vee bearings immediately led to pressure to continue the work for development of ring-type bearings. Evaluation tests showed that, from the standpoint of previously mentioned requirements, the only sacrifice made in the Vee bearing was in resistance to shock.

The allowable shock or impact that a bearing will withstand is a function of both the deceleration and the weight of the instrument moving system carried by the bearing. For lightweight moving systems, below 0.75 grams, sapphire has a large factor of safety. Glass bearings have therefore been applied to instruments with these lightweight moving elements without a sacrifice in usable shock resistance.

Ring bearings have been made experimentally up to 0.5 in. outside diam., and holes have been molded down to 0.005 in. diam. The length of parts in general does not exceed 0.250 in., and a minimum as low as 0.010 in. is envisioned.

In general, the processes developed to produce glass bearings are much simpler than those required to turn out sapphire jewel bearings. The techniques developed inherently give low cost and accurate dimensional control, and may have many other uses for the production of precision glass parts.

—J. H. Goss. *Product Engrg.*, Vol. 15, Mar. 1944, pp. 170-173.

## Low-Copper Duralumin

*Condensed from "Zeitschrift für Metallkunde"*

Continuing previous research that successfully reduced the copper content in duralumin from 4.2 to 3%, the physical properties of 2% Cu-bearing duralumin were thoroughly investigated in relation to composition (variation of silicon and magnesium contents) and precipitation hardening treatments.

The extensive research yielded the following most favorable compositions: Alloy I, 2 Cu, 0.7 Mn, 0.9 Mg, 1.0% Si, bal. Al; Alloy II, 2 Cu, 0.7 Mn, 1.4 Mg, 0.8% Si, balance Al.

Alloy I, containing considerably more silicon than necessary to form $Mg_2Si$, requires precipitation hardening at temperatures above atmospheric. Hardening at 320

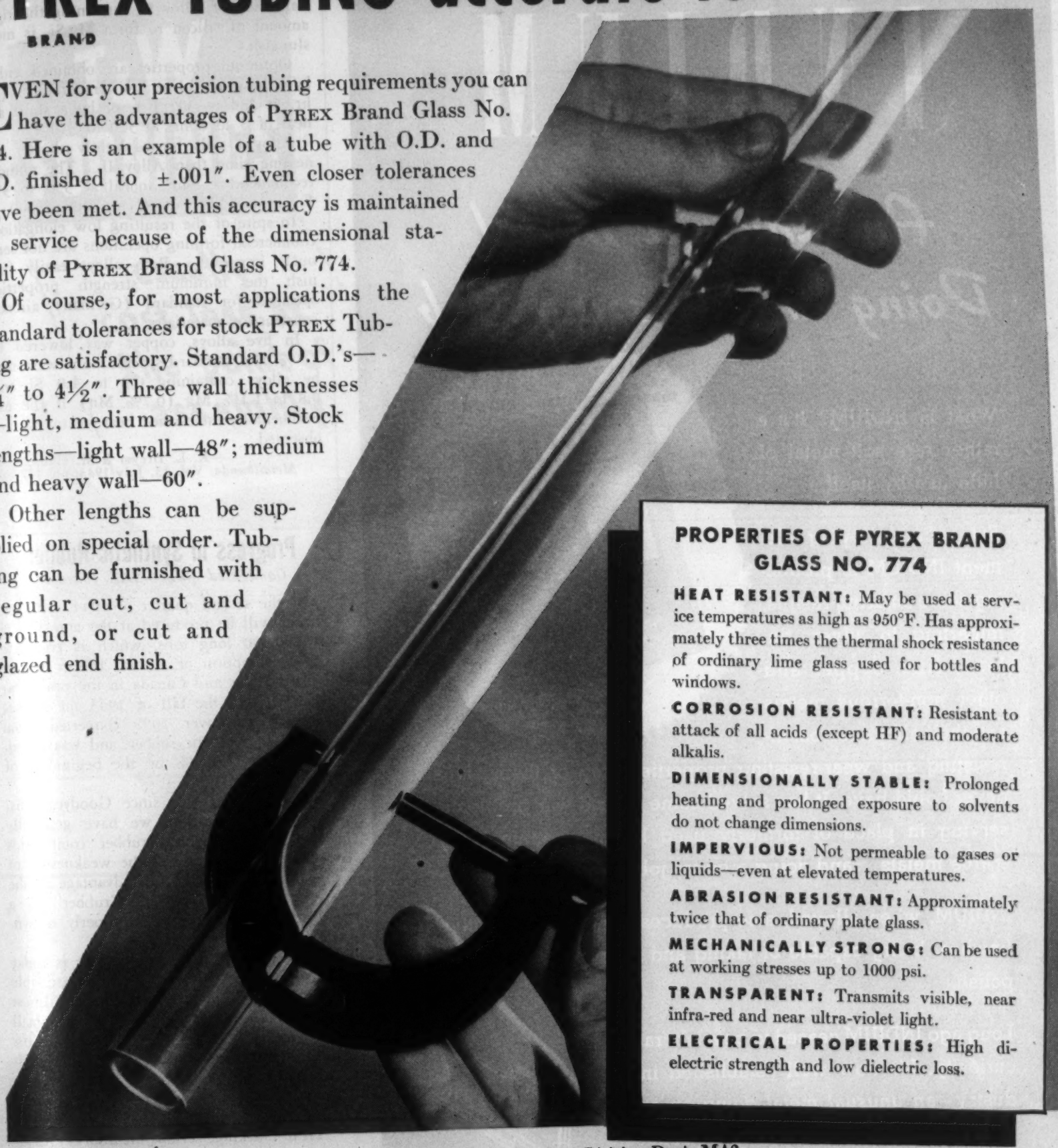
# PYREX TUBING *accurate to ± .001"*

BRAND

EVEN for your precision tubing requirements you can have the advantages of PYREX Brand Glass No. 774. Here is an example of a tube with O.D. and I.D. finished to ±.001". Even closer tolerances have been met. And this accuracy is maintained in service because of the dimensional stability of PYREX Brand Glass No. 774.

Of course, for most applications the standard tolerances for stock PYREX Tubing are satisfactory. Standard O.D.'s—¼" to 4½". Three wall thicknesses—light, medium and heavy. Stock lengths—light wall—48"; medium and heavy wall—60".

Other lengths can be supplied on special order. Tubing can be furnished with regular cut, cut and ground, or cut and glazed end finish.



## PROPERTIES OF PYREX BRAND GLASS NO. 774

**HEAT RESISTANT:** May be used at service temperatures as high as 950°F. Has approximately three times the thermal shock resistance of ordinary lime glass used for bottles and windows.

**CORROSION RESISTANT:** Resistant to attack of all acids (except HF) and moderate alkalis.

**DIMENSIONALLY STABLE:** Prolonged heating and prolonged exposure to solvents do not change dimensions.

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**ABRASION RESISTANT:** Approximately twice that of ordinary plate glass.

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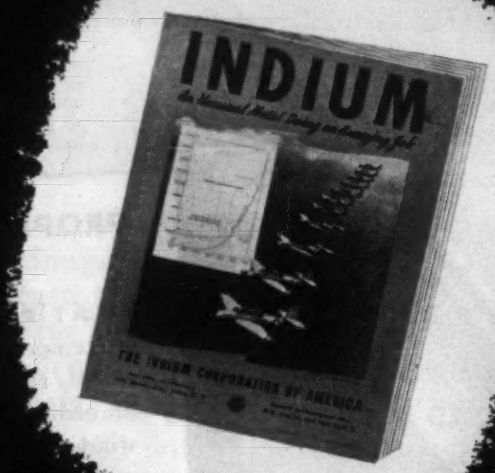


What is INDIUM? It's a rather rare soft metal of little use by itself.

*But,* as an alloying element INDIUM is producing some amazing results, imparting to silver, tin, lead, zinc, copper and other non-ferrous metals and their alloys corrosion-resisting and wear-resisting properties they of themselves never could have. It has solved some critical war problems, serving in place of formerly used but now strategically scarce metals... and doing a better job.

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Long ago INDIUM ceased to be a laboratory curiosity. It's now well established in industry—*an unusual metal doing an amazing job.* As pioneers and largest producers of the country's INDIUM, we have summarized its accomplishments to date in an 8-page brochure. Send for a copy and get acquainted with this metal.

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F. results in high yield point values and considerable loss of ductility. The hot hardening of Alloy II, containing the right amount of silicon to form $Mg_2Si$, is more sluggish.

Optimum properties are obtained either by a long anneal at low temperatures (24 hr. at 284 to 302 F.), or by a short anneal of 5 to 8 hr. at 320 to 340 F.

Alloy I calls for a slightly shorter annealing time than Alloy II. The authors recommend a 5-hr. anneal at 356 to 374 F., or a 24-hr. anneal at 320 to 340 F.

In spite of the resulting low elongation, commercial forming operations are not seriously impaired. Both alloys easily furnish the minimum strength properties specified for standard (German) aircraft construction materials.

In five alloys, copper was lowered to 1.7%, and standard specifications were met by alloys containing 0.9 to 1.0 Si and 0.8 to 1.1% Mg (0.7% Mn) if the experimentally established heat treatments are observed.

—K. L. Dreyer & M. Hansen. *Z. Metallkunde,* Vol. 35, July 1943, pp. 137-146

## Progress in Synthetic Rubber

*Condensed from "SAE Journal"*

By the second quarter of 1944, synthetic rubber will be produced at the annual rate of 800,000 long tons, which is equal to the consumption of natural rubber in the United States and Canada in the peak year of 1941. In the fall of 1943 the rubber industry was over 50% converted from natural to synthetic rubber, and was scheduled to reach 80% by the beginning of this year.

For 104 years, or since Goodyear discovered vulcanization, we have gradually developed the natural rubber compounds of today, which protect the weaknesses of the material and take full advantage of the strong points. Synthetic "rubber" is a misnomer — it is more properly a synthetic elastic material.

The synthetic passenger car tire is today a satisfactory product. At reasonable speeds it will deliver performance almost equal to the best pre-war tire. The small civilian truck tires are reasonably satisfactory on light trucks, though performance drops rapidly with extreme overloads. Army trucks generally are not overloaded.

Tread cracking, serious on highway tires, is not serious in Army tires because of the non-directional cross-bar design. Truck tires, 8.25 section and up, are still a most serious problem. Temperature of the synthetic tires at rated load is approximately equal to the natural rubber tire at 30% overload.

With a synthetic, there is apt to be excess cracking and splitting when a cut or other injury breaks the tread surface. The life of synthetics is increased threefold when overload of 30% is eliminated.

Rayon reduces the running temperature of the synthetic, making it equal to, or lower than the natural. Large synthetic truck tires are reasonably satisfactory, if made of high tenacity rayon and if extremes of overload and speed are avoided,

(*Continued on page* 1508)

# T&W FORGINGS

## usually cost less at the point of assembly

Heat treating forgings should be, and usually is, a straightforward production procedure that is controllable at every stage. This may become a factor of prime importance in meeting post-war competitive conditions, when the element of time will be of even greater moment as a cost factor than it is today. The fact that in forgings it is possible to obtain uniformity of physical properties in the exact degree desired reduces rejections and checking time. With T & W forgings you get the utmost of these advantages. Ask a T & W Forging Engineer to explain how uniformity of physical properties in T & W Forgings *usually reduces cost at the point of assembly.*

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but such rayon is scarce and hardly available for civilians.

GR-S inner tubes are reasonably satisfactory, except for the smaller sizes used on drop-center rims where the high well stretch causes many premature failures. These may be improved in time by using butyl rubber. On army tanks synthetic works well on bogie rollers and tank treads.

On several automotive mechanical goods, particularly where oil must be resisted, synthetics work well, such as water pump seals, radiator hose, brake hose, fan belts, grommets, gaskets, insulators, and channel rubber for windshields, windows, door edgings and windshield wipers.

In lines other than rubber, it often happens that the synthetic process improves on nature. History will probably repeat itself in the rubber industry.

—P. M. Torrance, *SAE Journal*, Vol. 52, Apr. 1944, pp. 133-136.

## Fatigue Strength of Aluminum Alloys

*Condensed from "Metallwirtschaft"*

In elaboration of previous investigations, further fatigue tests were made with aluminum alloys of the types, aluminum-magnesium-silicon, aluminum-magnesium, and aluminum-magnesium-manganese, with load oscillations up to 50,000,000 under different kinds of load, rotating-bending, flat-bending, tension-compression and torsion.

By the use of a specially developed rotating bending machine for load oscillations of 3000 to 10,000 per min., it was possible not only to shorten the testing time to one-third, but also to use a shorter test specimen length. The bending fatigue strength of transverse (to the fibre) specimens of round rods of 55-mm. (2¼ in.) diam. is about 25% lower than in longitudinal specimens, the same as for tensile strength and elastic limit.

An influence of the diameter could not be found between 4.4 to 9.5 (1¾ in. to 3¾ in.). The bending fatigue strength of the smooth rod of duralumin was higher for round rods in pressed state than in rolled or drawn state, and that of the notched rod about 1 kg. per sq. mm. (1400 p.s.i.) lower.

For the smooth alloy, however, the values of the drawn rods are always higher for both smooth and notched rods than those of the pressed or rolled specimens. The torsion fatigue strength of pressed rods of the type Al-Cu-Mg is lower than that of drawn or rolled specimens; no such differences were found in the smooth specimens.

No difference in the bending fatigue strength was found in sheets that were made from cast or pressed slabs. While in smooth-surfaced specimens the rotating-bending fatigue strength of both smooth and notched rods is improved by cold-hardening as compared with the soft condition, and still more by hot-hardening, duralumin shows the best values in the normally hardened condition.

Hot-hardening increases the rotating-bending strength of the smooth rod only in case of tempering immediately after quenching, but deteriorates in any case both notch-fatigue strength and notch-sensitivity;

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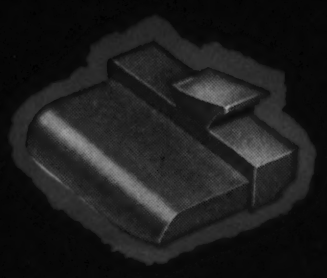

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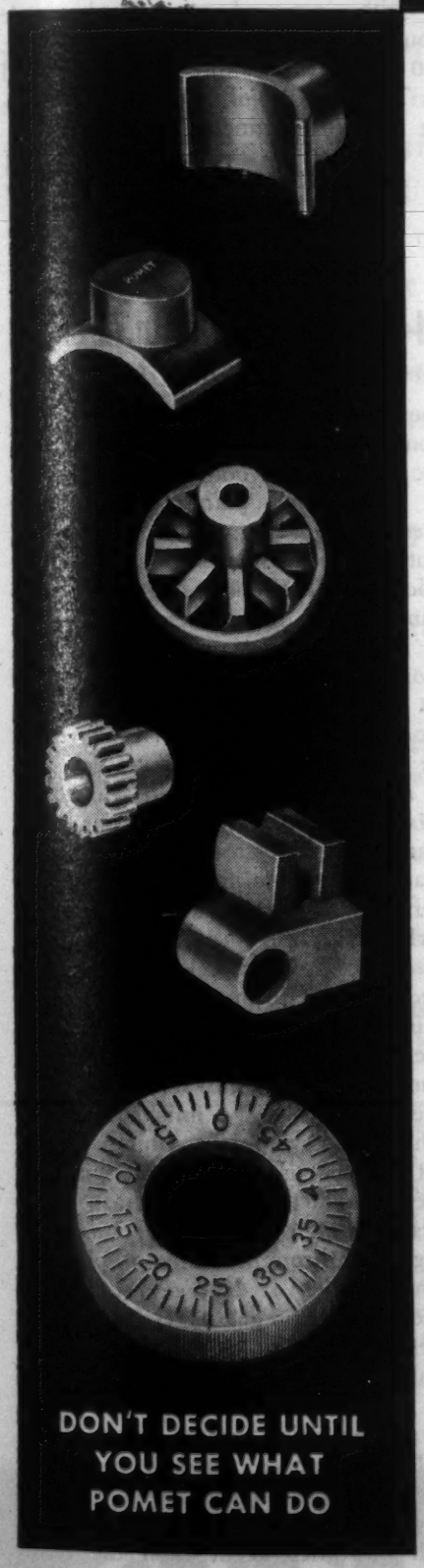

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these two latter properties are also unfavorably influenced by soft-annealing. A coarse-grained aluminum-copper specimen had only about 5% lower bending fatigue strength than a fine-grained specimen.

Holes of 3 mm. (0.12 in.) in 3-mm. thick sheets of duralumin reduced bending-fatigue strength about 25 to 30%. The absolute value of the drilled specimen is independent of surface quality (polished or with rolling skin) and also, in the range from 30 to 60 mm. (1.2 to 2.4 in.) thickness, of width of specimen.

Gas-fusion welding reduces bending-fatigue strength 25 to 30% in the various duralumin types, and 40% in smooth-surfaced. Corrosion-fatigue tests with 2-mm. (0.08 in.) thick sheets (with rolling skin) showed at 50 million load oscillations a reduction of the fatigue strength of 50 to 70% in duralumin types, but only about a third at 1 million load oscillations.

The tensile-compressive strength for duralumin at 50 million load oscillations of 11 kg. per sq. mm. (15,600 p.s.i) decreases to 8.5 kg. per sq. mm. (12,100 p.s.i.) with increased prestressed tensile load, but increases to 14 kg. per sq. mm. (20,000 p.s.i.) for compressive pre-stressed loads. This may be of importance in connecting rods for engines.

—E. V. Rajakovics. *Metallwirtschaft*, Vol. 22, Apr. 20, 1943, pp. 225-239.

## Wood-Paper Composite in Aircraft

*Condensed from "Aero Digest"*

A new airplane material, Consoweld, is a combination of high strength paper, phenolic resin and wood, and is used in gliders and power planes, for primary structures and flooring. Solid Consoweld (without a wood core) parts are in quantity production for gun turret sub-assemblies, ammunition boxes, etc.

It is being experimented with as covering for plywood fuselages, troop seats, etc. It is primarily paper, treated with phenolic resin and formed under heat pressure into a solid panel. It is often used as a sandwich material in which plywood is between two layers of Consoweld.

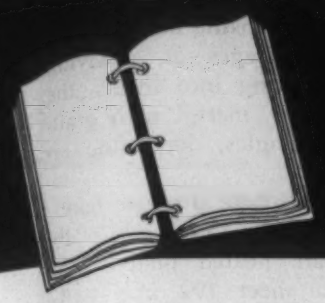
A search for the strongest paper available located the Consolidated Water Power & Paper Co., which makes a paper of Mitscherlich sulphite pulp, a slow cook pulp of spruce. Consoweld, produced in laminated plastics form, transforms paper into an infusible, insoluble, dense, uniform, high strength, light weight material, equalling aluminum in tensile strength on an equal weight basis. The finished material has a hard glossy finish, which is one reason it may be used for entire wings.

In the manufacture, the aircraft paper goes first through the treater machine, then is guided through a tank of phenolic resin, from which it emerges coated on both sides and impregnated right through the paper. Dyes can be added to give a considerable choice of colors.

From the resin bath the paper passes through a long drier, heated by an automatic oil-fired furnace, fitted with pyrometers. It is then cut into sheets.

Consoweld binds readily to a wood surface with no other agent than the resin

# Designing Molded Plastics Parts: RIBS BOSSES FILLETS



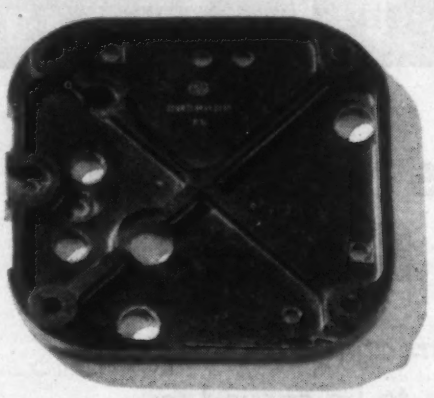
## From the engineering files of One Plastics Avenue

**Ribs, bosses and fillets are often essential to molded plastics parts. The following general factors should be considered in design specifications:**

1. **Design ribs with ample section and sufficient draft or taper. A taper of 5° per side is desirable on all high bosses and ribs. Provide generous radii at top and base.**
2. **Large otherwise unsupported surfaces should be designed with ribs to provide adequate mechanical strength and minimize warpage.**
3. **Fillets increase strength of mold and of molded part, prevent lodging of compound in corners with resulting premature cure.**
4. **Mounting bosses should project at least 1/64 in. beyond other projections on molded part.**
5. **Ribs act as runners or feeders and may be used to flow materials to isolated bosses or projections.**

**RIBS** are used to provide strength, facilitate flow of material, or act as an electrical barrier. Ribs may be used on one or both surfaces. When ribs are used on inside surface of light-colored material, decorative ribbing on outer surface may be necessary to conceal lines or shadows.

For urea parts ribs should be as short as possible and of uniform thickness, approximating thickness of main section.



Control part in which ribs provide strength, bosses simplify mounting and assembly, and fillets improve moldability and appearance.

**BOSSES** are used for mounting or assembly. When four bosses are used for mounting molded parts it is usually necessary to grind their top surfaces flat. Three bosses are preferable as they do not require this finishing operation. For small bosses the height should not be more than 2 times the diameter. High bosses tend to trap gas, decreasing density and strength, of molded part. For bosses in side walls of light-colored parts decorative fluting on outer face will conceal any shadows or flow lines.

**FILLETS (or radii) at base of ribs or bosses facilitate flow of compound and eliminate sharp corners which concentrate stresses in molded part.**

**Fillets on inside ribs or bosses minimize shadows or flow lines which may appear on outer surfaces.**

**Fillets frequently reduce mold costs, improve appearance of part, and eliminate dust traps which make part difficult to clean. They also improve the mechanical and dielectric strength of part.**

**Molded part should have at least 1/32 in. radius for all corners, with the exception of flash lines which should be sharp. Cold molded parts should have 1/16 in. minimum radii.**

**ADDITIONAL FACTS Proper design of ribs and bosses improves serviceability of molded parts and contributes to economical manufacture. G.E. offers a consulting engineering service based on experience, successful production and complete molding facilities. For additional information about plastics or for reprints of this advertisement, write section F-217, General Electric Plastics Divisions, 1 Plastics Avenue, Pittsfield, Mass.**

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already embodied in it. It may supplant coverings of fabric and paint now on plywood wings and fuselages at a saving in weight. After cutting into sheets, the paper is made up into "mats," with grain parallel or at right angles, depending on end use.

Mats go to presses where they are bonded under pressures of 75 to 250 lb. Presses employ steam heated platens, the largest producing a sheet 192 in. by 82 in. The mats are then molded between thin steel cauls. Then resin flow is trimmed off the edges and the pieces cut to size.

For sandwich material, basswood is usually used for the core, and edges of the sandwiches must be painted with moisture-resistant material. An important use is for floors in gliders and airplanes. Typical flooring material is called F-101 P, which weighs a maximum of 1½ p.s.f.

Static load tests show that this will support at least 2000 p.s.i. with the load applied through an 8-in. diam. solid rubber tire at the point in the center of a 10-in. clear span.

—Franklin M. Reck. *Aero Digest*, Vol. 44, Mar. 15, 1944, pp. 124, 126, 129, 132.

## Improved Lead Bearing Alloys

*Condensed from "Zeitschrift für Metallkunde"*

The lead-base bearing metals containing small additions of alkalines and earth-alkalines ("Bahn-Metall" or Bn-metal) possess excellent gliding properties, and contain no strategic metals. Their shortcomings are loss of hardening agents on remelting, and hardness changes when exposed to higher temperatures for longer periods of time. The object of this research was to overcome the latter two difficulties.

Schwidt redetermined the solubility of sodium in lead, and found that the sodium content in Bn-metal exceeds the maximum solubility at room temperatures to an extent considerably larger than assumed heretofore.

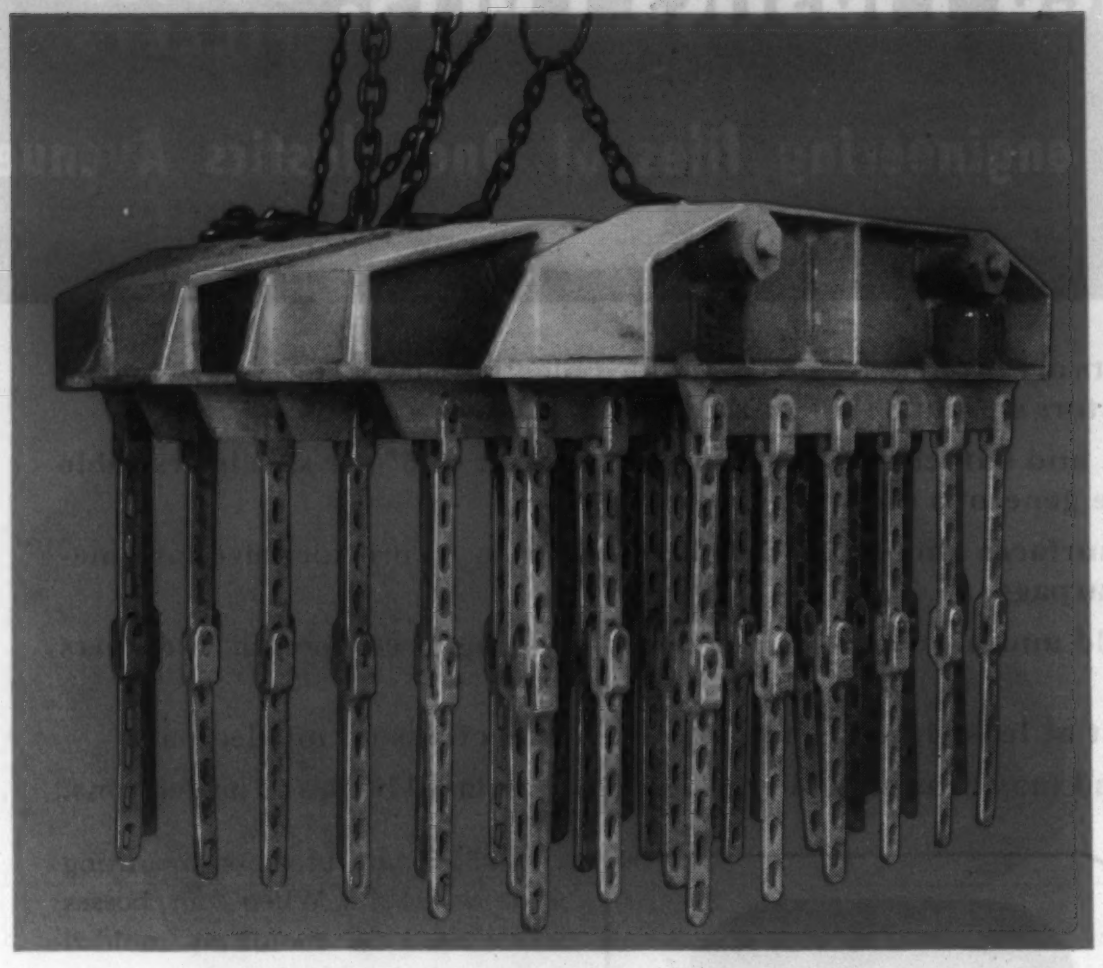
Hardness tests proved sodium to be the principal hardening element, followed by lithium. Sodium and lithium are reduced by two-thirds and one-half, respectively. Additions of barium were found to be advantageous, and lithium may be fully replaced by magnesium.

The more sluggish diffusion of the earth-alkalines as compared with the alkalines are responsible for a greater stability in regard to strength when the bearing undergoes temperature variations.

Losses in remelting are reduced materially, and the corrosion resistance of the newly developed bearings is the same as that of the old; the same holds for the gliding properties. Analyses recommended are: 0.7 Ca, 0.4 Ba, 0.2 Na, 0.02% Li and approximately 0.02% Al; 0.7 Ca, 0.4 Ba, 0.2 Na, 0.004% Mg and approximately 0.02% Al, bal. Pb.

It is claimed that these new alloys show no loss of strength in temperature ranges heretofore reserved for babbits.

—Erich Schmidt. *Z. Metallkunde*, Vol. 35, Apr. 1943, pp. 85-92.

# Where Materials Handling Requires Special Equipment

• Many present-day heat-treating methods include mass handling of parts to be carried to and from furnaces. Fixtures such as the above permit the use of slotted rods to form shelves or trays of different depths depending on the amount and kind of parts to be heat-treated.

For dependable, long heat-hour performance, the chief requirement is the uniformity of quality of the heat-resistant alloys. Those who recognize the importance of this requirement,—make sure of satisfaction by sending the job to MICHIANA.

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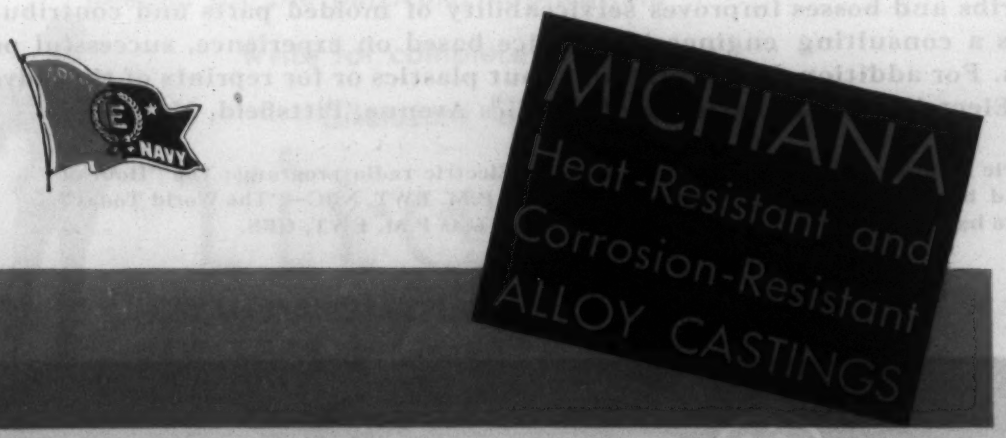
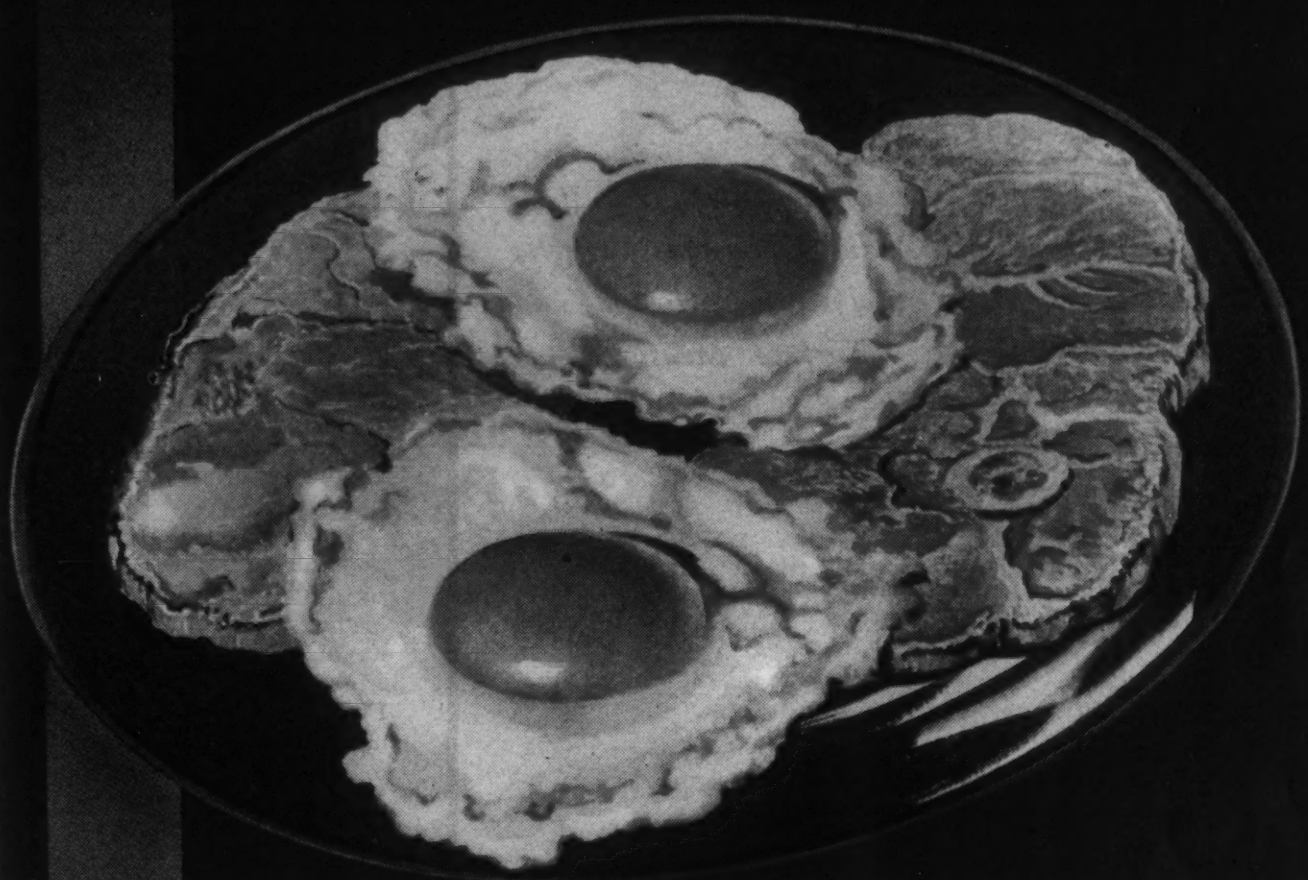


# HAM & EGGS



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## Dynamic Hardness

*A Composite*

The new concept of dynamic hardness has many practical applications in metallurgical engineering heretofore insufficiently appreciated. Two recent publications—a two-part article in *The Iron Age,* by Erich Fetz (Vol. 152, Dec. 23, 1943, pp. 42-53; Dec. 30, 1943, pp. 40-52), and a book on "Hardness," by D. Landau, published by The Nitralloy Corp., New York, 1943, 105 pp., contain much information about this property.

The resistance to plastic deformation at fast working speeds is not determined correctly in conventional static hardness testing. Dynamic hardness tests should be applied when (1) imitating in the laboratory the conditions in hot and cold working at fast strain rates, such as cogging, forging, riveting, rolling, extruding, deep drawing, etc.; (2) studying service conditions where impact forces prevail; and (3) determining hardness changes due to phase changes above the recrystallization temperature.

Even close to the melting point, considerable resistances to plastic deformation have been lately discovered in high-speed testing. In slow-speed or static tests, the same materials appear to be much softer, having had sufficient time to be relieved of the working stresses when deformed above the recrystallization temperature range.

Similar considerations hold when determining the resistance to fracture in high-speed vs. zero-strain rate tensile tests. The present state of dynamic hardness testing is discussed.

Fetz critically reviews British, German and Japanese dynamic hardness data obtained at elevated temperatures on alloy steels for high-temperature use, tungsten and molybdenum high-speed steels, stellite and substitution alloys of lower strategic metal content, nickel-chromium and cobalt-chromium alloys, special brands of 18/8, wrought aluminum alloys, brass, bronze, copper-aluminum, etc.

Reporting his own dynamic hot hardnesses of a tungsten-chromium-vanadium and chromium-tungsten-silicon die steel, the author shows the effect of different heat treatments on the softening rate and temperature of drastic softening. The efficiency and economy of the dynamic hot hardness tester is emphasized.

Two modern dynamic hardness testers for medium and high temperature work are illustrated. The latter machine, designed by the German Institute for Aeronautical Research, has been extensively used in developing valve steels and hard facings on airplane motor valves. For instance, the content of strategic cobalt (60 to 65%) in standard stellites could be cut in half on the basis of dynamic hot hardness and other tests.

Landau also deals with the technique of hardness testing including dynamic, history and principles underlying different methods and structural details of various machines. However, the importance of Landau's treatise, subtitled "A Critical Examination of Hardness, Dynamic Hardness and an Attempt to Reduce Hardness to Dimensional Analysis," lies in its discussion of the theoretical aspects of "hardness."

In spite of the wide technical application of hardness testing, "hardness" has defied true scientific definition. It is felt with Roudié that the solution of hardness is now on its way via a study of dynamic hardness.

The principal dimensional properties affecting the hardness of metallic and nonmetallic materials are their elastic limit and modulus of elasticity. Hardness and elasticity are inseparable manifestations of molecular energy which dynamic methods can only define and measure.

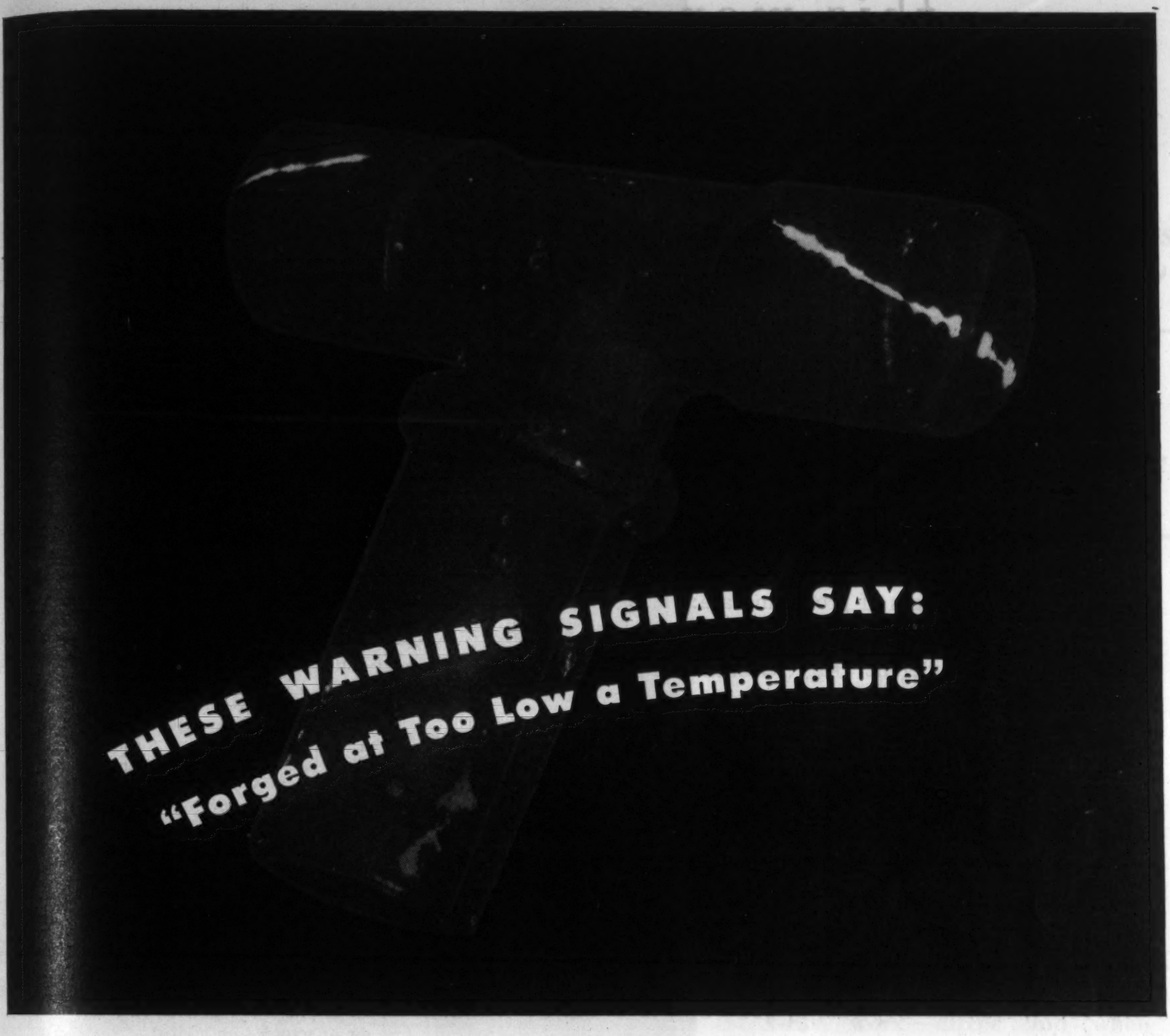
It is shown that hardness can be reduced to and expressed—as many physical quantities—in terms of length, mass and time.

## Inspecting Involute Spur Gears

*Condensed from "The Iron Age"*

Spur gears are the practical solution to the mechanical problem of transmitting uniform rotary motion from one shaft to another parallel shaft at a definite ratio of rotative speeds. If errors prevent a full bearing across the faces of the teeth, stress concentration may cause rapid wear or surface fatigue.

Errors in profile, in spacing, and in lead are three fundamental types that, if integrated, will describe deviations of the actual gear from the ideal gear. As errors may vary at various points on the tooth surface, the

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What is even more important the indications can be interpreted to show WHAT caused the defect. It is only a step further to decide what to do to correct the trouble and pass only perfect parts to the customer in the completed product. The illustration shows a forged aluminum alloy pipe fitting with indications of cracks resulting from forging at too low a temperature.

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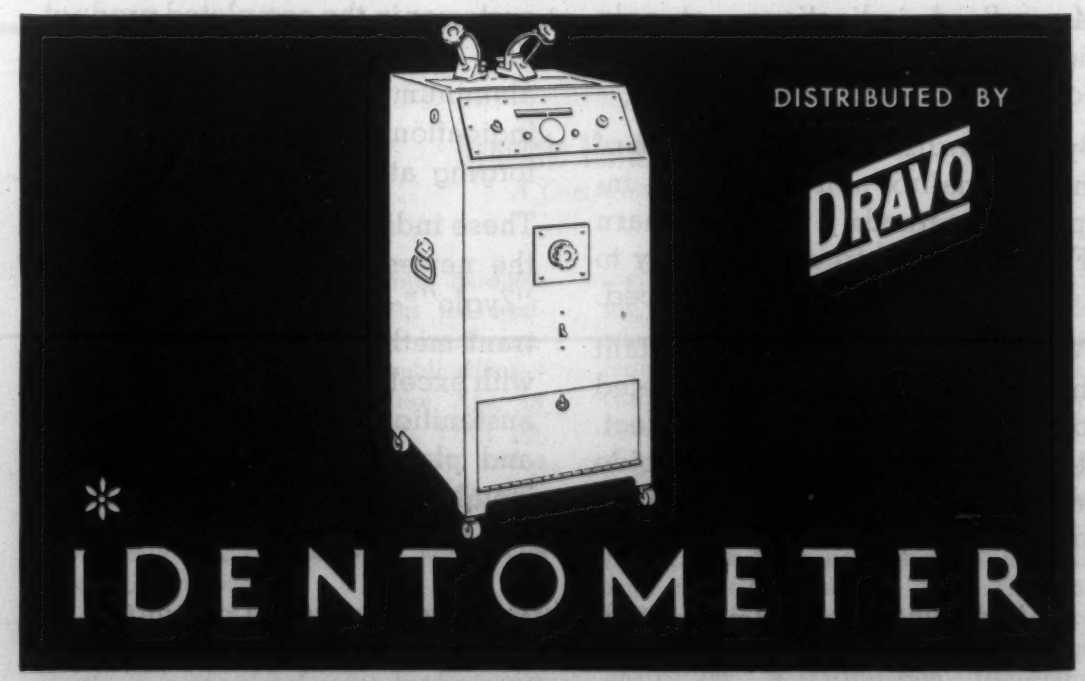
# * identifying STEEL
# *positively*

Provided with a known sample of most rolled or forged ferrous alloys, he can tell instantly if unknown pieces of almost any size or shape and in most stages of processing are: (1) of the same or different chemical composition, if the physical structures are the same; (2) of the same or different heat treatments, if the chemical composition is the same.

Identometer is a new and valuable tool for metallurgical separation. Stocks can be identified on receipt and stored correctly according to type. Material *should* be checked before expensive machining and processing is begun. Stocks that have been mixed can be quickly and accurately re-sorted.

Identometer works on the principle of thermo-electricity. It is portable, speedy, and accurate. For a quick summary of what it is and how it works, just write for Bulletin 213. Address DRAVO CORPORATION, *National Department*, 300 PENN AVENUE, PITTSBURGH 22, PENNSYLVANIA.




AN ELECTRICAL INSTRUMENT FOR THE INSTANT AND ACCURATE IDENTIFICATION OF MOST ROLLED OR FORGED FERROUS ALLOYS BY THE USE OF REFERENCE SPECIMENS


elements of which the surface is made up must be determined.

Errors in profile can be caused by the general displacement of the ideal profile. Thus, a perfect involute profile element when displaced radially or tipped in any direction with respect to a tangent line to the axis of rotation will be in error because it cannot be made to coincide with the profile element of the undisplaced ideal gear.

Another type of error in profile is a distortion from ideal, which may be caused by an error in the base circle. The ideal gear may be modified to compensate for deflection under load so that the tooth has a lead. The generatrix will then not be parallel to the axis of rotation but will be in the plane tangent to the base circle. If the tooth of the ideal gear is crowned, the generatrix will be curved.

In a given gear, any combination of profile, spacing and lead errors may exist, and the values may vary around the gear and across the face of the teeth. In many instances the variation in errors follows a definite pattern.

**Axis Displaced**

The most simple pattern is the gear that is geometrically the same as the ideal gear, except that the axis of rotation has been displaced parallel to the geometric axis. Another pattern of error occurs when an ideal gear is tipped with respect to axis of rotation.

Another class of errors encountered is found in general distortion of the ideal gear. The elliptical type of distortion may occur from heat treating or from machining the gear.

Direct measuring methods cover the actual measurement of involute profile, spacing, and lead. As full integration of these measurements is seldom practical, representative measurements are relied upon.

Involute profile is measured mechanically with a pointer contacting the profile and by any of various mechanical means made to move over it following a true involute path. Deviation from the true path by the actual profile is registered on a dial indicator or recorded on a chart.

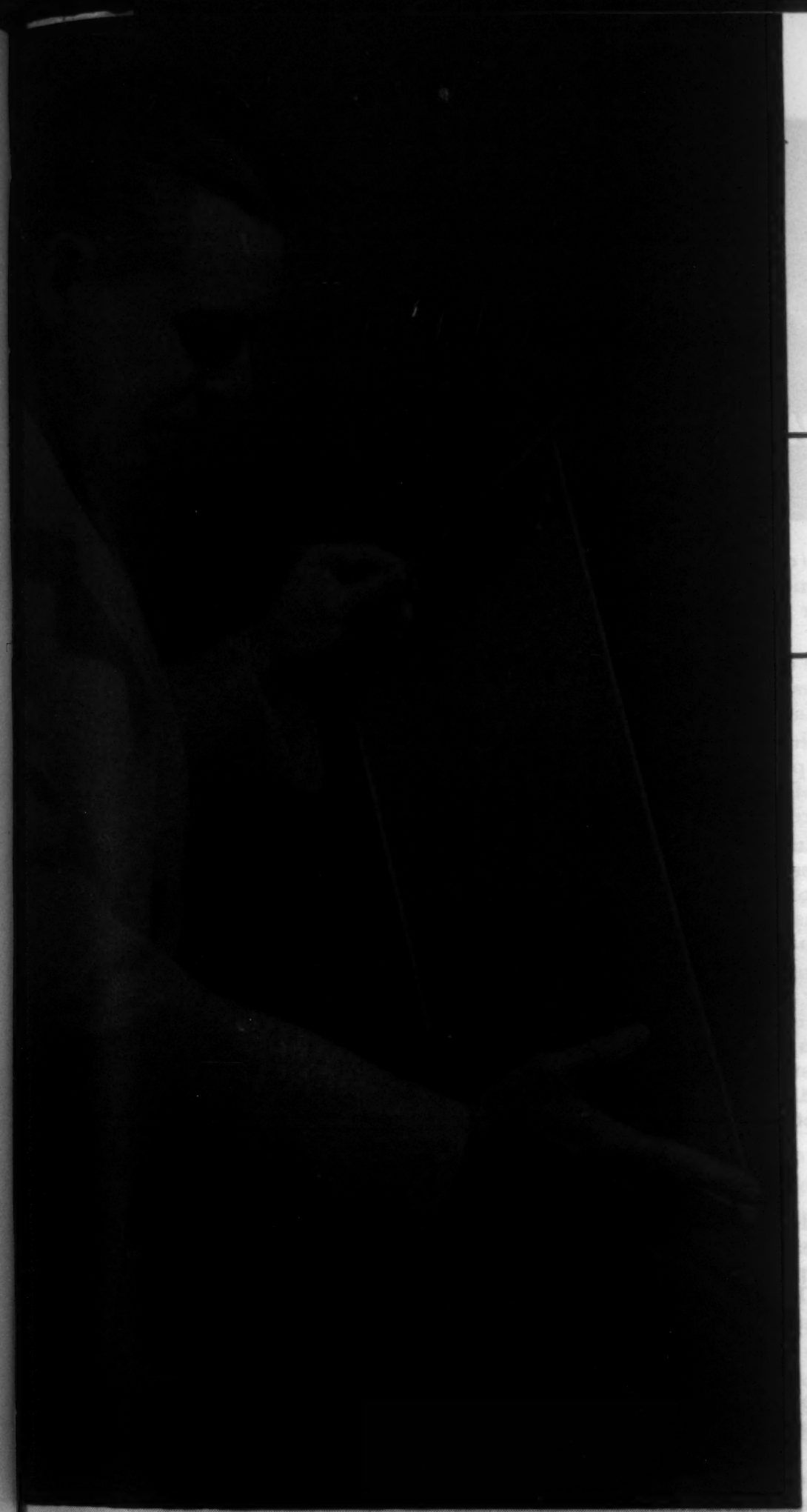
Involute profile can also be measured with an optical comparator if the face width of the gear is not too great, and if there are no shoulders on the gear blank that would interfere with the passage of the light. In this method the magnified shadow of the profile element at the inner or outer face of the gear profile is cast on a screen and compared with a layout of the ideal profile made to the same scale as the magnification. The optical method is excellent for measuring tooth thickness, root radius and other dimensions, but it is not used to check involute profile.

The principle of involute as a constant rise cam is sometimes used in measuring profile. This method is rather slow but has been used on master gears.

Absolute spacing error can also be measured with a precision dividing head with which angular displacement and the amount the actual tooth is out of position is measured with an indicator. A more rapid method consists of comparing distances between two points identically located on successive teeth with similar measurements all around the gear.

**Functional Inspection**

A common functional method is to run



**Kodak Provides the 4 Types of Film Needed in Industrial Radiography**

In addition to Type K . . .

***Kodak Industrial X-ray Film, Type M . . .*** "made to order" for critical inspection—especially of light alloys and, with million-volt radiography, of thinner steel parts.

***Kodak Industrial X-ray Film, Type A . . .*** primarily for light alloys at lower voltages and million-volt radiography of thick steel parts.

***Kodak Industrial X-ray Film, Type F . . .*** primarily for the radiography, with calcium tungstate screens, of heavy steel parts.

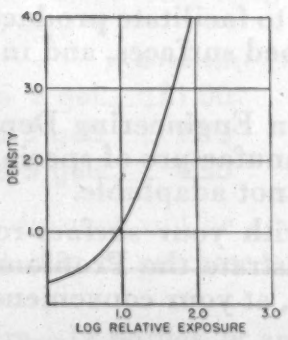
# Q

*Which x-ray film's high speed makes it especially advantageous with gamma radiation?*

# A

## *Kodak's Type "K"*

**Kodak Industrial X-ray Film, Type K, offers the highest available speed for gamma-ray exposures, with lead-foil screens, of heavy steel parts, and is recommended for all such work where exposure time must be kept to a minimum. It also provides the highest available speed, together with moderately high contrast, in x-ray work—direct and when lead-foil screens are used.**

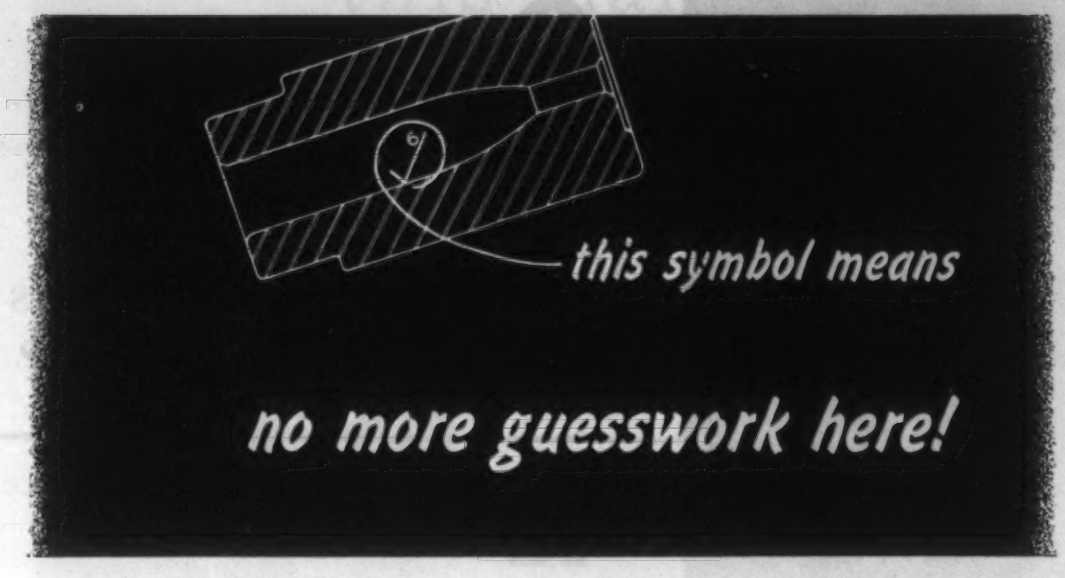



*Characteristic Curve, Kodak Industrial X-ray Film, Type K, with direct x-ray exposure.*

*Development: Five minutes, at 68°F., in Kodalk X-ray Developer.*

**EASTMAN KODAK COMPANY**
**X-ray Division Rochester 4, N. Y.**

Kodak




**THE ENGINEER, by using this symbol (or one of its variations), is specifying a definite surface finish measured in microinches. He has eliminated the guesswork that for years went into production of satisfactory surface finishes.**

**The engineer need no longer rely on the designation "f = smooth machined surface . . . " which he knows may produce as many different surfaces as there are men in charge of making the part.**

**And in preparing his specifications, the engineer can call for the surface most suitable for the work the part has to do. Very close tolerances can be set for the production of very smooth surfaces—or of rough surfaces where a pre-defined roughness is wanted.**

**The Profilometer* has enabled the simple, accurate measurement of surface roughness—making possible the fullest use of the roughness symbol shown. With the Profilometer, each part may be accurately checked on a production basis to make sure it meets blueprint specifications for surface roughness.**

**Roughness control by means of Profilometer readings has facilitated finishing to dimensions, prevented waste of materials and time, and enabled production of better surfaces on millions of machined parts going into war machines. Wartime experience in this regard indicates extensive application of surface-roughness control in peacetime manufacture. Inquiries are invited from manufacturers looking ahead to peacetime production.**

***The Profilometer . . .***

**The basic Profilometer unit is a complete shop instrument for measuring average surface roughness. Nearly all surfaces can be measured with this unit. This unit is supplemented by standard accessories available in the form of extra Tracers, piloting fixtures, and other devices to facilitate production measuring on very smooth surfaces, odd-shaped surfaces, and in slots, grooves, small holes and on tapers.**

**Our Application Engineering Department is fully equipped for the design and manufacture of special jigs and fixtures where standard equipment is not adaptable.**

**To help you with your surface-roughness problems, we would be glad to demonstrate the Profilometer equipment in your plant and on your parts, at your convenience and at no obligation to you.**

***May we send you a copy of our booklet Practical Measurement of Surface Roughness? In it is described the technic of surface-roughness measurement and the complete Profilometer equipment.***

***Profilometer is a registered trademark indicating Physicists Research Company's brand of surface-roughness gaging equipment**

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the gear with its mate or with a master gear that will duplicate the action of the mating gear. Another method is to mount the gear and master on parallel arbors at a standard center distance. Gears are then spun and a slight drag applied to one. The vibration felt is roughly interpreted as a function of gear errors.

In double-sided methods the indications of error are determined solely by the relation between errors on the drive side and those on the coast side of the teeth. As drive and coast sides may have independent errors, it is possible for the errors of one side to cancel errors of the other side when the two are inspected simultaneously.

One type of double-sided method consists of running the gear with a master gear with center-to-center pressure to keep the gears tightly meshed. The other type does not attempt to measure profile errors. It consists of measuring pitch-line runout with a pin, ball, cone, rack tooth, or rack space.

All types of inspections mentioned have been used successfully. If a complete picture of gear quality is to be obtained, provision to check functional or double-sided methods against fundamental methods should be had.

—Sidney Cornell. *Iron Age*, Vol. 153, Mar. 23, 1944, pp. 68-73, 144.

## Simplified Gaging

*Condensed from "Screw Machine Engineering"*

Usually, screw machine products are rather difficult to gage efficiently without the use of special gages. Although it is natural to get individual gages for the parts, the cost and delay must be considered, especially if the necessity for a gage is not realized until the part is in production.

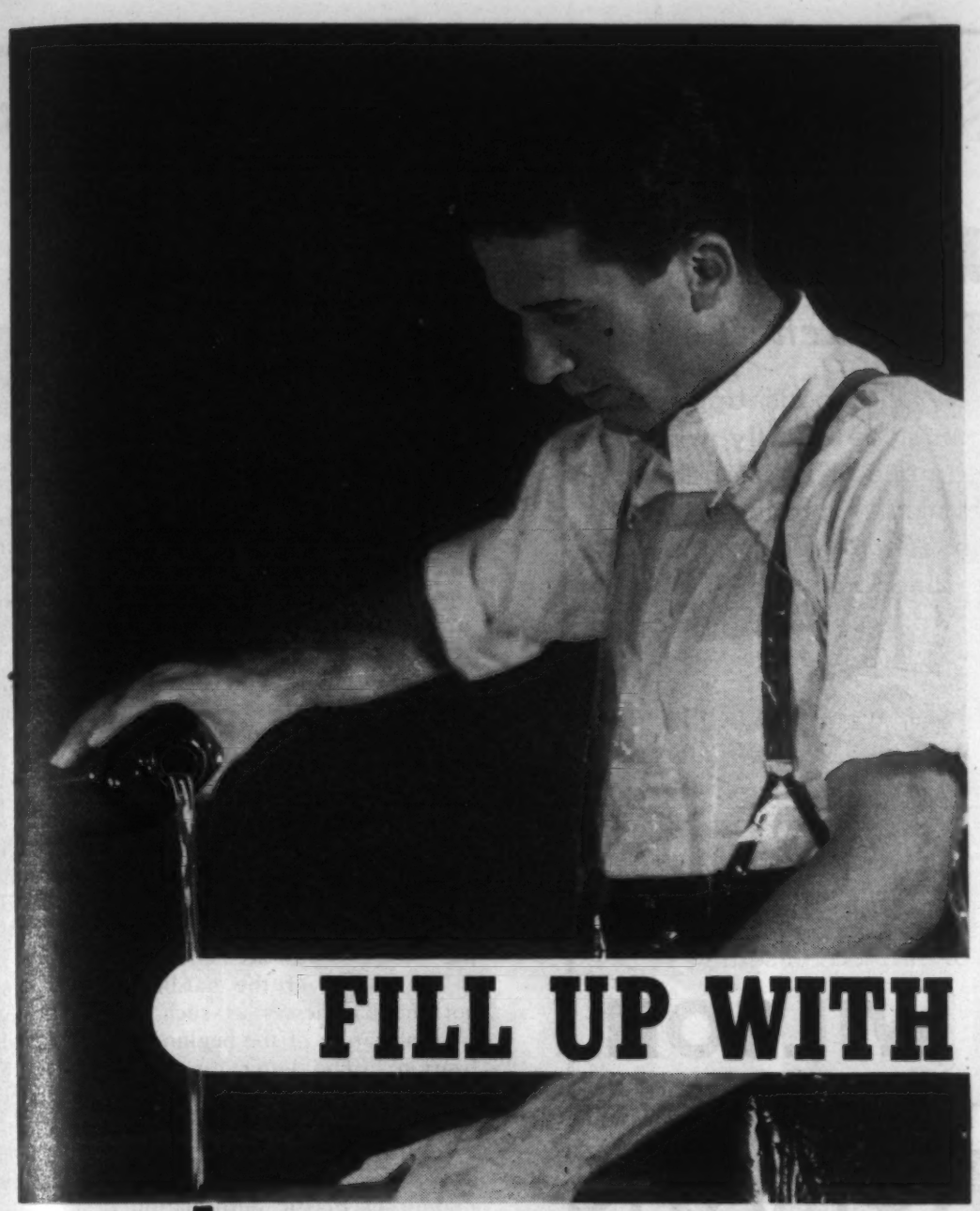
A simple gage block is described that is of great practical value in relieving gaging bottlenecks in any screw machine products plant or automatic department. It is made of mild steel, which is then drilled, hardened and ground.

The design depends on the general average of work. Fundamentally, it is a block with holes of different sizes for holding the parts to be measured. The example given is 4 by 3 in. by the desired thickness, with 27 holes of graduated sizes arranged in four rows. Usually four or five blocks of varying thickness will cover requirements.

For convenience, the thickness is varied in hundredths, or multiples thereof. The holes will cover a greater range of parts if the size of the holes is increased in increments of 0.010 or 0.015 in. in diam.

As an example of the use of this block, consider a screw part with a radiused screw head and a shoulder. If it is put in a block thicker than the dimension from the base of the head to the end of the threaded portion, and the height measured from the under side of the gage block to the top of the screw head, then the height of the head is obtained by subtracting the thickness of the block.

If the part is then put in a hole smaller than the shoulder, the next measurement will give the height of the shoulder. The final measurement is a simple over-all gaging of the part. In this way, all di-



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For higher quality films, faster and more economically processed, refill your tanks with Supermix. Order today from your nearby G-E Branch Office.

| | Developer | Refresher | Fixer |
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| To make 1 gal. | $1.00 | $1.15 | $1.00 |
| To make 3 gals. | 2.75 | --- | 2.70 |
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*Prices f.o.b. U. S. Branches. Prices will be increased by the amount of such sales (or use) tax as may be applicable.*

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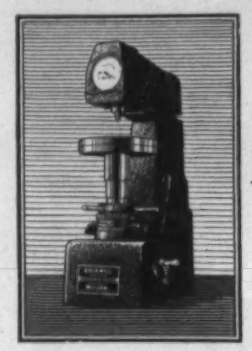
HARDNESS TESTER



*WHY the Load Applying Weights Are Standard and Not Made Up Individually For Each Tester.*

We weigh precisely the loads applied by each tester and they must be exactly what the standardized weights, amplified by standardized levers, should mathematically produce. If they fail to produce the correct load at the penetrator, then there is something wrong somewhere and we find out what it is. We never tamper with the weights nor do we ever use a non-standard leverage.

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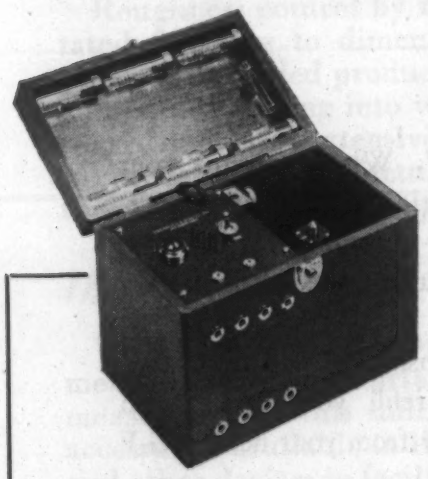

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*Hardness Testing!*

The Eberbach Micro Hardness Tester is unique in its ability to measure hardness of micro constituents of metallic alloys. Originally developed as a research instrument, this highly precise, modern laboratory production tool is now widely used to check hardness specifications of pieces too small for other testers, of plated surfaces and nitrided and cyanided layers.

The indenter unit, equipped with standard microscope society threads is designed to mount on any metallurgical type microscope. An accurately ground diamond indenter permits measurement directly in fundamental units, instantly convertible to other systems. The area to be tested is located with the objective, and the indenter unit substituted. The focusing adjustments are used to indent the specimen and measurements are made with the micrometer eyepiece.

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mensions can be obtained without the use of special gages.

—A. Ainsworth, *Screw Machine Engrg.*, Vol. 5, Feb. 1944, pp. 41-42.

## Crystal Recovery vs. Recrystallization

*Condensed from "Zeitschrift für Metallkunde"*

Hardness-time curves and microphotos were obtained on mild steel stretched between 5 and 20% and annealed for 10 min. to 24 hr. in the temperature range of from 1150 to 1650 F.

The object of this extensive research was to study the characteristic features of crystal recovery (changes of physical properties without apparent micro-structural changes) and of recrystallization (microscopic changes of deformation texture).

In the case of crystal recovery, only a partial softening takes place without any further loss of hardness on prolonged annealing at low temperatures.

The horizontal course of such a hardness-time curve takes a pronounced dip and shows a distinct turning point if crystal recovery is followed by recrystallization. The latter quickly overtakes the former and no "turning point" on the hardness-time curve is noticeable if the annealing temperatures are raised.

The course of the hardness curves and not the hardnesses as such represents the true indication of the beginning of recrystallization. The latter can be more clearly determined on samples subjected to different degrees of cold working.

In the case of crystal recovery, the final hardnesses are the higher the greater the amount of plastic deformation. However, if recrystallization takes place, this order is reversed, *i.e.* the greater the amount of cold work, the faster and more pronounced the softening.

—A. Pomp & G. Niebsch. *Z. Metallkunde*, Vol. 35, May 1943, pp. 111-117.

## Creep Load Tests

*Condensed from "Zeitschrift für Ver. deut. Ing."*

The authors believe that the short-time tests used in practice to determine the mechanical strength of steels at elevated temperatures have proved to be unsatisfactory. Empirical data derived in practice were mainly used in design, which left an uncertainty when the composition of the steel was changed.

A new series of investigations was therefore deemed necessary, which was to determine especially the effect of time on the properties of deformation and strength of steels at higher temperatures and to elucidate the mechanism of creep phenomena.

Fractures can occur in three types: Crystal fracture with previous crystal deformation, grain boundary fracture with previous crystal deformation, and grain boundary fracture without previous crystal deformation or after recrystallization.

The tests established the facts that at elevated temperatures fractures in connection with gliding phenomena within the crystals are preceded by large amounts of deforma-

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# ANALYSIS OF ALL METALS

Save MAN-HOURS

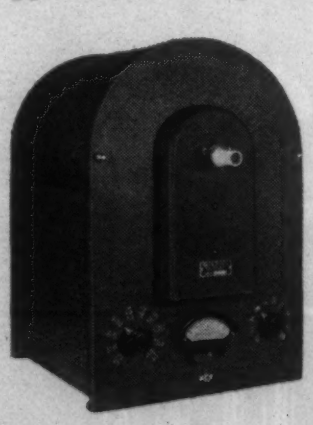
## 3-MINUTE SULFUR DETERMINATOR

The improved Sulfur Determinator provides rapid and accurate sulfur determination of coal, coke, irons, alloy steels, and other ferrous or non-ferrous materials. The time required for a complete analysis, exclusive of weighing sample, is 3 minutes.

The determinator has a substantial base and supporting column for holding glassware. Three 2-liter solution bottles insure ample supply of chemicals for the two automatic pipettes and burette.

A simplified titration vessel facilitates cleaning, eliminates breakage of expensive glassware, and enables the operator to leave a sample burning while the other is being titrated. The bubbler is also removable so that it may also be easily cleaned.

The Varitemp Furnace, illustrated at right, has a temperature range up to 2750° Fahr. and is furnished complete with transformer, pyrometer, voltage control, and power switch. This unit may be used with either the Carbon or Sulfur Determinator.



## 2-MINUTE CARBON DETERMINATOR

The improved 2-minute Carbon Determinator enables operators to determine carbon content of all metals with speed and accuracy. It incorporates new features which eliminate much of the human equation and simplifies procedure. A complete determination can be made within 2 minutes after the sample is weighed.

A mechanical elevator raises and lowers the aspirator bottle and reduces fatigue of the operator and improves accuracy.

The absorption vessel is of a "U" tube design and provides a positive means of having the gas pressure in the Determinator at atmospheric pressure at the end of the combustion period and at the time the reading is taken. At the atmospheric liquid level is located a capillary tube with a line marker. This eliminates the doubtful eye leveling procedure and inaccuracies due to difference in pressure at the start and finish of test.

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CONTROL EQUIPMENT — SAVES TIME

*Harry W. Dietert Co.*

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tion, and that the transition from gliding to creeping can produce a fundamental change in the mechanical behavior of the material, especially in the finished structure.

Fractures that occur in connection with pure gliding and translocations at the grain boundaries without simultaneous gliding in the crystal interior appear brittle at the exterior. A mathematical treatment of the creep phenomenon is not yet possible, no sufficiently large numbers of long-time tests being available.

Attention must also be called to the fact that creeping in a test is different from creeping in the finished structure where, besides natural forces such as weight and pressure, other forces, such as prevented expansion by heat, stresses in joints, etc., influence the creep.

### Time Strength

It is therefore proposed to introduce another characteristic for a material, the so-called "time strength"; while the creep strength indicates the maximum load that the material will stand for any length of time, all loads higher than creep strength are termed "time strength."

Such loads, higher than creep strength, eventually lead not only to fracture but also cause slowly progressing injuries to the structure. The mechanical properties of the material are in this way reduced.

This "injury line" can be determined by the changes in tensile strength, notch-impact toughness, or in other mechanical properties under varying temperatures, and gives the basis for the safe dimensioning of structural parts. The effects of notches, surface quality, etc. has to be taken into account.

It is assumed that in creeping, two opposing effects take place—one the improvement of the mechanical properties by gliding, the other the simultaneous loosening of the structure or injury, which makes itself felt only after some time. At first, the latter is over-shadowed by the gliding improvement.

The manner of determining the load-time-strength diagrams is described, and the results of tests at 500 C. (930 F.) are given in the attached table:

| *Material* | *Heat-Treatment* | *Mechanical Properties* | | | |
|---|---|---|---|---|---|
| | Quenched from — in — Drawn at — in — | Tensile strength kg./mm.² at 20 C. | Creep strength kg./mm.² at 20 C. | Time to fracture for creep strength hr. | Time strength for 1000 hr. life kg./mm.² |
| Not alloyed | normalized 900° — air | 48.5 | 3.5 | 70000 | about 7 |
| Cr-Mo steel | 630° — air 870° — oil | 62.4 | 16.5 | 60000 | 22.5 |
| Ni-Mo-Cr steel | 590° — air 1050° — oil | 89.1 | 31 | 2500 | 21 |
| Cr-V steel | 740° — air 950° — air | 82.2 | 24.5 | 2500 | 20 |
| Cr-Mo-V steel | 680 — air | 91 | 31.2 | 3000 | 25 |
| Cr-Ni steel | 1030 — water | 70.5 | 21 | 100000 | 31 |

—A. Thum & K. Richard. *Z. Ver. duet. Ing.*, Vol. 87, Aug. 21, 1943, pp. 513-520.


# Transparent VITREOSIL

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**The following descriptive bulletins will be sent you on request: Standard Apparatus and Utensils—Bulletin No. 10, Drawn Tubing and Rod—Bulletin No. 9, Special Apparatus and Equipment — Bulletin No. 5.**

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## X-Ray Gaging Propeller Blades

*Condensed from "Aviation"*

To provide an accurate means of measuring the thickness of the plate of a hollow steel propeller blade in airfoil shape, attention was directed to X-ray analysis. Sectioning, a "destructive" method, and caliper methods, which are limited in accuracy, were unsatisfactory.

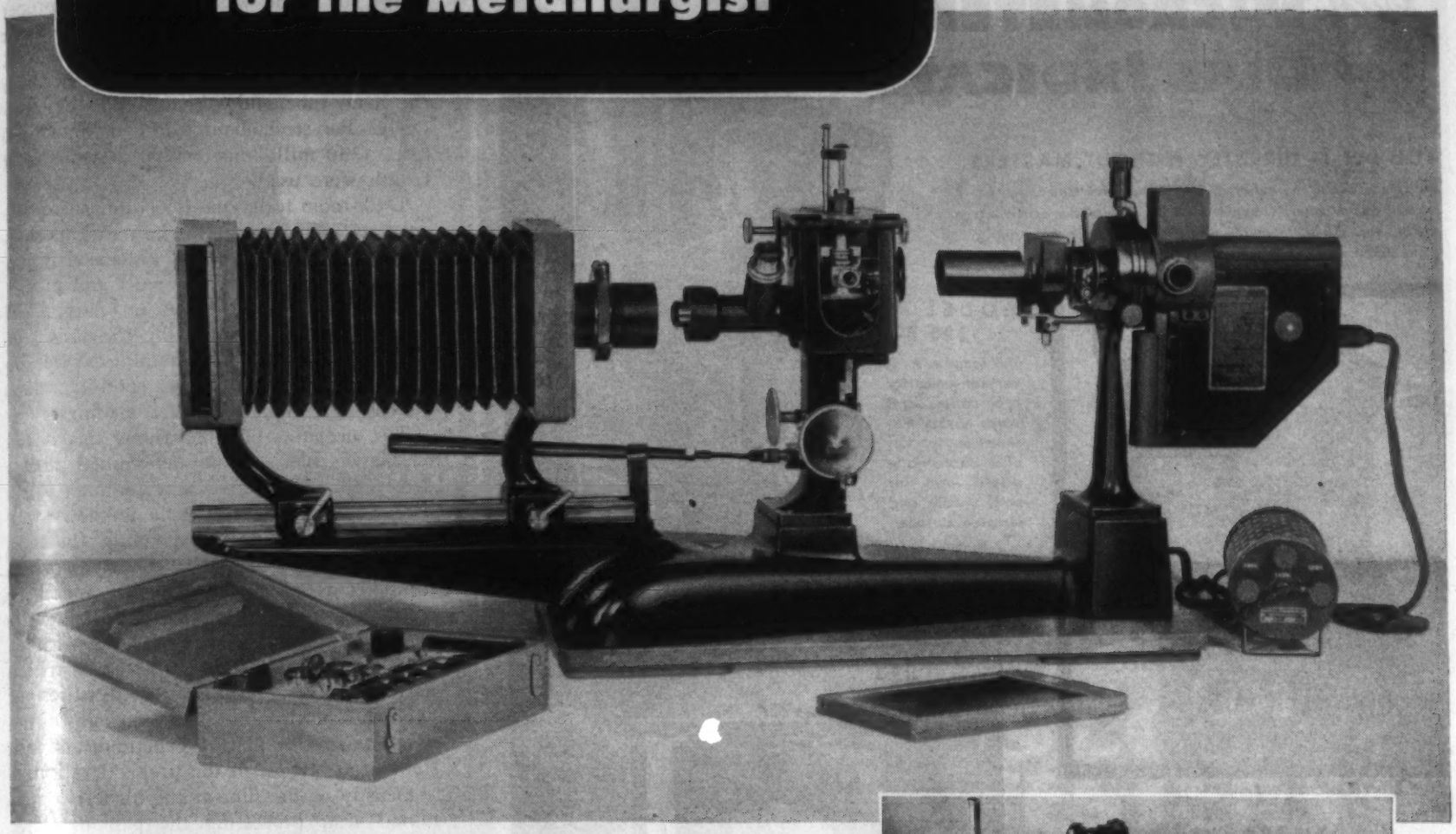
The basis of the method is that a given source of X-radiation of suitable wavelength will, under controlled conditions, penetrate the plate with a certain intensity, this being a definite function of the thickness of plate involved.

If the intensity of X-ray penetration of the plate of known thickness be studied, the results can be applied to similar action on the plate of unknown thickness.

Preliminary shots were made with 1-in. squares of the steel used in propeller manufacture, ground in 0.020-in. steps, with thickness ranging from 0.060 to 0.300 in. The minimum kilovoltage capable of penetrating the stock under consideration was used in order to produce the maximum change of film density for a given change in thickness of material. A standard transmission densitometer was used for measuring all film densities.

Commercial, fine-grained, high-contrast non-screen film was used. To minimize back scatter, a 0.015-in. lead backing strip was placed immediately behind the film. A 0.005-in. lead filter was used immediately in front of the film to eliminate effects of secondary rays and to provide an intensifying effect.

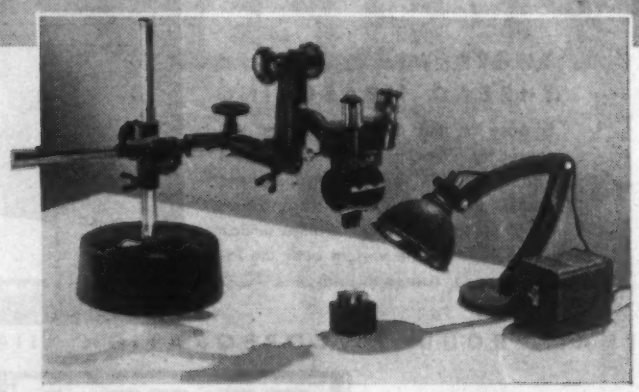
# Buehler Optical Equipment for the Metallurgist



## *Metalloscope B&L—MILS for visual observation and photography . . . bright field work*

This equipment consists of a special inverted microscope and a photographic camera with suitable light source mounted on one rigid base. The inverted microscope is fitted with vertical illuminator having both plane glass and prism reflector. The mechanical stage is a regular feature. A wide range of objectives and eye pieces is available for both visual and photographic work. The camera plate opening is 5″ x 7″ with kits for 4″ x 5″ and 3¼″ x 4¼″. Sufficient extension is provided for photographic magnifications according to ASTM standards of 25X to 2000X with objectives and eyepieces regularly listed.

**THE BUEHLER LINE of optical equipment for the metallurgist includes microscopes • spectrographs • macro cameras • magnifiers • metallographs and other essential apparatus.**



**Wide Field Binocular Microscope—No. 2230 B&L—SKW-5 with reflector lamp**

Affords a wide field; realistic three-dimensional vision for the inspection of small parts. This piece of apparatus has unlimited use and should be a part of the equipment in every metallurgical laboratory. The complete outfit as illustrated consists of prism body; drum nosepiece; 3 objectives and 2 sets paired eyepieces to provide approximately 7X to 45X or higher. Reflector lamp can be supplied as a separate item.

*Adolph I. Buehler*

OPTICAL INSTRUMENTS

228 NORTH LA SALLE ST., CHICAGO 1, ILLINOIS

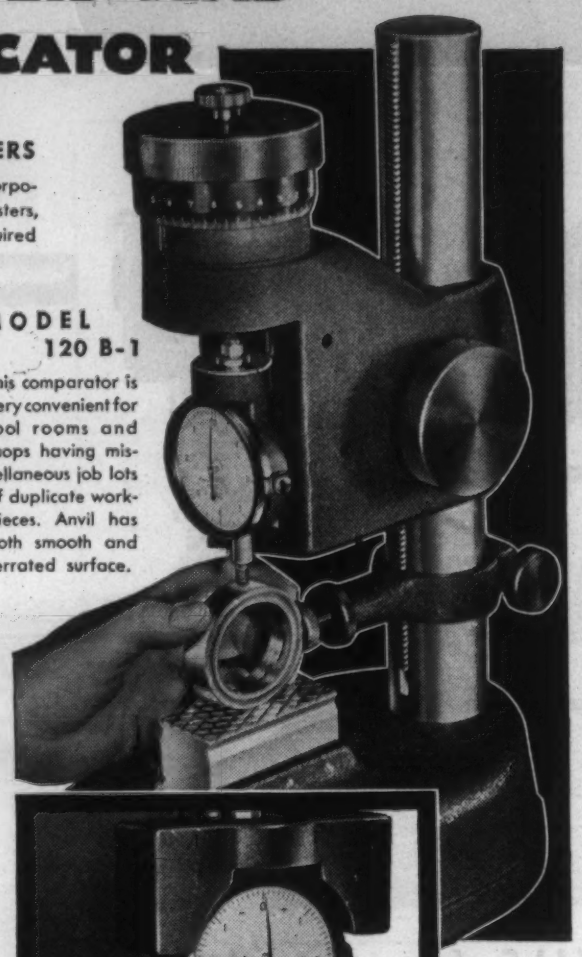
# It's New - a COMPARATOR with MICROMETER HEAD and DIAL INDICATOR

**YOU SET IT DIRECTLY WITHOUT MASTERS**

The combination Micrometer and Dial Indicator Head incorporates its own Master. A complete set of Gage blocks, or masters, are not necessary. You simply set the micrometer to the required dimension, lock it, and then compare workpieces, etc.

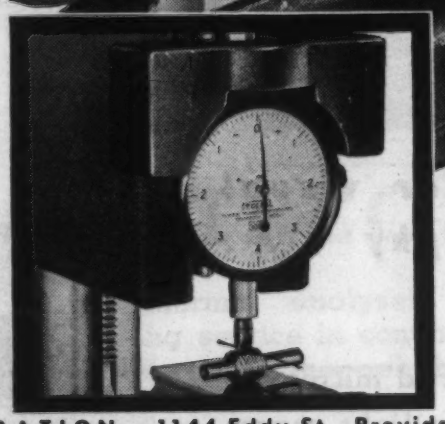
**MODEL 120 B-1**

This comparator is very convenient for tool rooms and shops having miscellaneous job lots of duplicate workpieces. Anvil has both smooth and serrated surface.



**THREE-WIRE THREAD MEASURING**

is easy on this new comparator because the Micrometer Head enables you to read the actual dimension of the Pitch Diameter. The Dial Indicator then compares the diameters of other similar screw threads. The weight over the Indicator is for coarse threads.



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"Feeling" a measurement is relative—"seeing" it is exact.

Use **Dial Indicators** for your gaging, so your inspectors can *see* whether the dimension is *right* or *wrong*—and *how much* wrong.


Only lead of filter-screen quality should be used.

To measure the blade-wall thickness, 7 by 17 in. films were cut in two, one piece being placed inside the blade while the other was used under the test blocks. The holder inside the blade was maintained in proper position by locating it with a rubber bladder blown up to hold the film to the contour.

The two films were located directly under the X-ray tube, and were exposed simultaneously. For steel about 0.150 in. thick, 130 kva., 1350 milli-amperes and a 90-in. focal length were used.

Dark-room technique is of utmost importance. A circulating system in the development tank is helpful. Simultaneously exposed films were hung in pairs and processed through the development, fixing, and washing tanks. Before drying, the films were rinsed in a solution containing a wetting agent, to eliminate any water spotting, which interferes with densitometer readings.

The densities of the various thicknesses of known blocks were determined, and a density-thickness curve was plotted. After determining the density of the unknown wall of the blade, the corresponding thickness is read from the curve. In ten tests in which comparisons of thicknesses determined by sectioning and by the new method were made, the maximum error was 0.006 in.

When thicknesses are known to be within narrow ranges, plotting the densities of "known" blocks and plate thicknesses can be eliminated by placing penetrameters with steps of 0.010 in. in the proper location.

Density of the film of the blade is determined after processing the pair of films. Then, density of the film of the penetrameter is determined and the two steps noted, one more and one less dense than the film of the blade. The thicknesses of the step penetrameter being known, a special chart indicates in thousandths how much to add or subtract to determine the thickness of the blade.

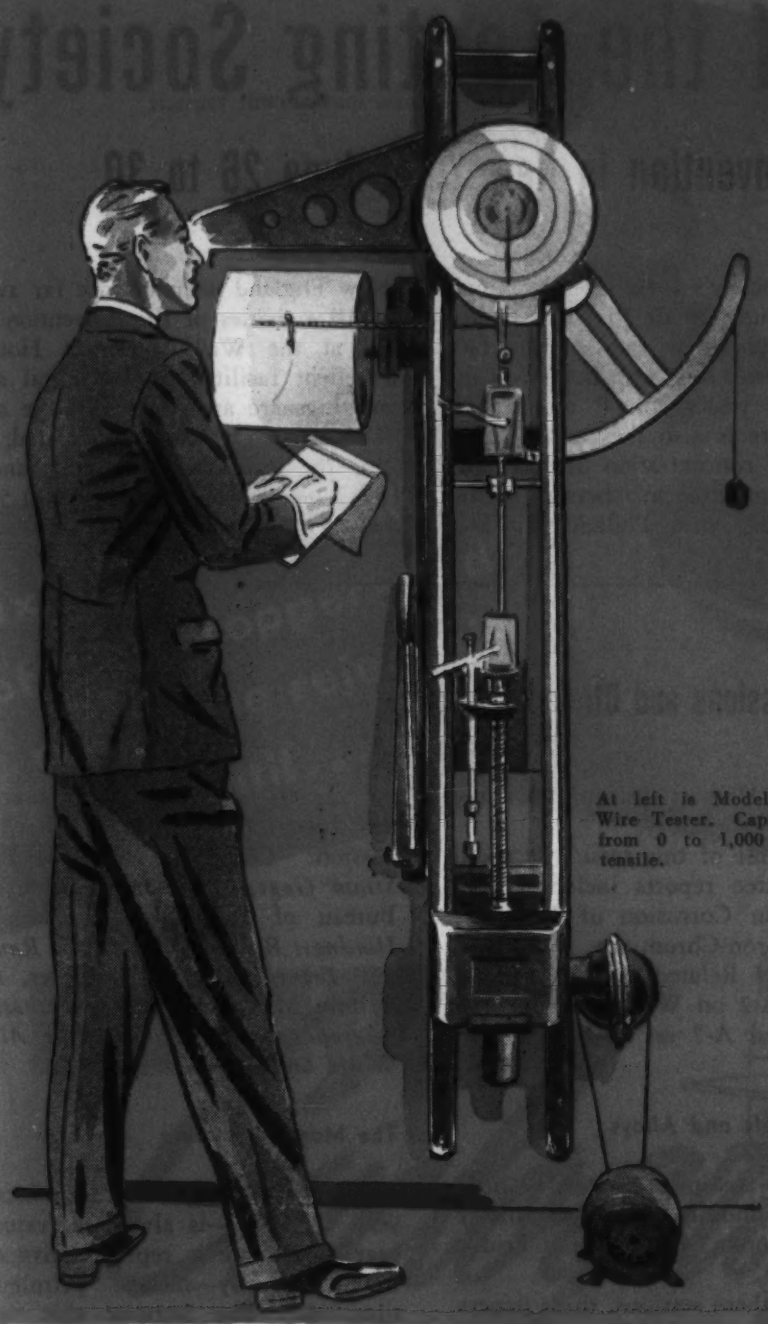
—H. P. Moyer. *Aviation*, Vol. 43, Mar. 1944, pp. 147, 275-276, 279.

## Strain-Aging of Killed Steel

### A Correction

On page 707 of the March issue of METALS AND ALLOYS there appeared a digest, "Strain-Aging of Killed Steel", which was accredited to the British publication *Metallurgia* without any further indication of authorship. Our attention has been called to the fact that the article published in *Metallurgia* and signed there "By a Special Correspondent" is actually based almost completely on a paper by G. F. Comstock of Titanium Alloy Mfg. Co., presented before the American Society for Testing Materials at its June 1943 meeting.

We regret very much that proper credit to the author and his employer and to the ASTM was not given in our digest, but the omission is excusable, for the British reprint of the paper did not clearly state that it was based almost entirely on Mr. Comstock's publication.



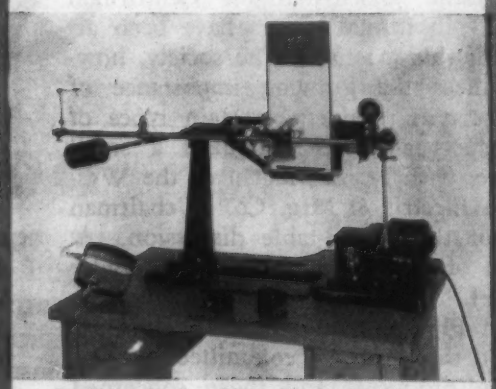
At left is Model J-5 Wire Tester. Capacity from 0 to 1,000 lbs. tensile.

# TESTERS for WIRE

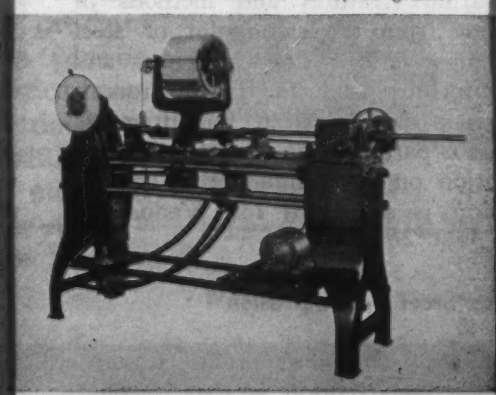
*Finest filament to 1 Ton*

**SCOTT TESTERS**

* Registered Trademark



Exclusive Incline-Plane Machine. For tensile and hysteresis tests on finest filament and other wires from 0 to 2,000 grams.



Model Q-7 Tester. Capacity 2,000 lbs. Heavy duty machine to stand up multiple-shift production testing.

With some 60 models to choose from, there is a suitable *Scott Tester for each of the various exacting requirements of tests on wire. Machines perform tensile, hysteresis, twist, compression-cutting (of rubber coating) and other tests from finest filament wires to 1 ton tensile. Among the important advantages is the picturized form of result chart, providing permanent value as research and production records. Let Scott engineers assist in developing test methods to suit your current problems—regardless of whether or not new equipment may be indicated.

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**65 Blackstone Street Providence, R. I.**

*Scott Testers — Standard of the World*

# Annual Meeting of the Testing Society

## A:S.T.M. Engineers to Hold Convention in New York, June 26 to 30

THE ANNUAL general convention of the American Society for Testing Materials has usually been held at Atlantic City at least two years out of every three. So many of the large hotels of that famous resort have been taken over by the Army or Navy, it has been necessary during the war to select some other location.

New York City has been selected as the place for the Society's forty-seventh annual meeting, from June 26 to 30. This choice is considered logical in view of the fact that the spring meeting was held in Cincinnati and last year's annual meeting in Pittsburgh. There is also the consideration that the greatest concentration of A.S.T.M. members and committee members is in the Metropolitan area, with Philadelphia and New England members not far away.

All activities of the convention will center at the Waldorf-Astoria Hotel where excellent facilities for technical and other meetings are available. A large attendance is expected. It is not anticipated, however, that the record-breaking attendance at the 1937 meeting in New York (1,533 members, visitors, etc.) will be broken.

## The Technical Sessions and Other Meetings

From the nature of the scope of this important society, the topics at the various technical sessions embrace many fields—water; cement and concrete; plastics; petroleum; coal and coke; paints; textiles; metals, both ferrous and non-ferrous; and so on. In this brief preview of the sessions, some 15 in all, only those will be touched on which concern the metals and the metal-working industries.

### Centrifugal Castings

Prominetn among these sessions is a Round Table Discussion on Centrifugal Castings. No formal papers have been arranged for this meeting. The society, however, realizes the growing importance of this process in producing certain types of cast products and has organized a small committee, with N. L. Mochel of the Westinghouse Electric & Mfg. Co. as chairman to sponsor this round-table discussion. A. E. Schuh of the U. S. Pipe and Foundry Co., and J. T. MacKenzie, of the American Cast Iron Pipe Co., and other leaders are serving on this informal committee.

Leading producers and those concerned with the use of centrifugal cast parts will discuss various features and methods of this process from the standpoint of steel castings, and various brass, bronze, and other non-ferrous products. In this round-table session, the American Foundrymen's Association is participating officially through representation on the committee in charge. This session is scheduled for Wednesday morning, June 28.

### Steel, Alloy Steel and Corrosion

One of the always important sessions of this annual convention is that devoted to steel and iron, scheduled for Thursday morning, June 29. Only two technical papers are listed for this meeting: *"The Technical Cohesive Strength of Some Steels and Light Alloys at Low Temperatures"* by McAdam, Mebs and Geil of the National Bureau of Standards, and the *"Geiger Counter Spectrometer for X-Ray Powder Diffraction"* by Herbert Friedman of the Naval Research Laboratory.

Most of the time of this session is taken up with committee reports including A-1 on Steel, A-5 on Corrosion of Iron and Steel, A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys, E-4 on Metallography, A-2 on Wrought Iron, A-3 on Cast Iron and A-7 on Malleable Iron Castings, etc.

### Non-Ferrous Metals and Alloys

There are two sessions devoted to non-ferrous metals including powder metallurgy —Thursday afternoon, June 29 and Friday morning, June 30.

At the first of these sessions, three papers are scheduled: *"Evolution of Test Specimens for Non-Ferrous Castings"* by A. J. Smith, *"An Alternate Immersion Test for Some Aluminum-Copper Alloys"* by Mears, Walton and Eldredge of the Aluminum Co. of America, and *"Basic Requirements in the Standardization of the Salt Spray Corrosion Test"* by L. J. Waldron, National Bureau of Standards.

The rest of this session is taken up with five committee reports: B-5, B-1, B-4, B-3 and B-9, which is the new committee on Metal Powders and Metal Powder Products.

There are three technical papers listed for the second non-ferrous session: *"Micro-Deformation under Tension and Compression Loads of Thin Aluminum Alloy Sheets for Aircraft Construction,"* by Georges Welter, *"Short Time Tests of Solders and Soldered Joints,"* by J. A. Kies and W. F. Roeser, National Bureau of Standards, and *"A Numerical Rating Method for the Routine Metallographic Examination of Commercial Magnesium Alloys,"* by P. F. George, The Dow Chemical Co.

Reports of Committees B-2, B-7, B-6 and B-8 are also scheduled for consideration.

### Fatigue and the Testing of Metals

Early in the week—on Tuesday afternoon, June 27—a session is devoted to Fatigue and Methods of Testing. Besides six reports of standing committees, there are three technical papers offered for discussion: *"Characteristics of the Tuckerman Strain Gage,"* by B. L. Wilson, National Bureau of Standards, *"Factors Affecting Hardness Relationships in the Range 50 to 250 Brinell,"* by R. H. Heyer, American Rolling Mill Co., and *"Quantitative Spectrographic Analysis of Copper Alloys,"* by Wolfe and Jemal.

### The Marburg Lecture

The annual Edgar Marburg Lecture this year, the 19th—is always a feature. Each year the lecture is representative of a different industry—metals, petroleum, textiles, etc. The lecturer this year is a specialist in the textile industry—Dr. Harold DeWitt Smith of A. M. Tenney Associates, New York City. His subject is "Textile Fibers—An Engineering Approach to an Understanding of Their Properties and Utilization." This lecture is scheduled for 4:30 p. m., Wednesday, June 28.

Honorary membership will be awarded at this session to three outstanding long-time leaders in the society's work.

### A General Session

The address of the retiring president, Dean Harvey, will be delivered at the usual general session on Wednesday evening, June 28. His subject will be the "Art of Living" with particular emphasis on the relation of this topic to the materials engineer and technologist.

Besides this there will be a special "guest address" by Dr. Charles K. Leith on "Minerals and World Peace."

### Committee Meetings

All day Monday, June 26, is devoted to meetings of regular committees and subcommittees with some of these scheduled during the week. It is expected that from 200 to 250 technical groups will be holding such meetings.

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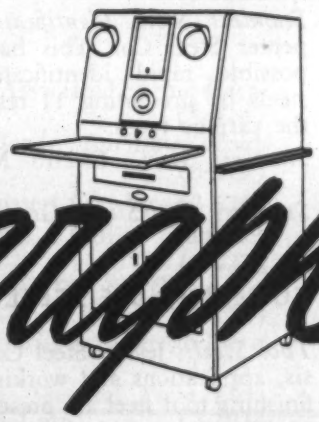

## SALVAGED ALL BUT 55,000

These cups were stamped out of a clad steel sheet, with thicker cladding on one side than on the other. When properly made, the cups have the thick cladding on the outside. If the sheet is reversed in the stamp, the cups are then made with the thin copper on the outside, and *must be rejected.*

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# Manufacturers' Literature

## YOURS FOR THE ASKING

## 1. Ferrous Metals

### ALLOY IRONS

*Molybdenum Iron and Steel.* Climax Molybdenum Co. (1-76)
*Ductile Alloy Iron.* Ferrous Metals Corp. (1-250)

### ALLOY STEELS

*Steel Analysis Chart.* American Steel & Wire Co. (1-218)
*Basic Open-Hearth Alloy Steel.* Andrews Steel Co. (1-166)
*Low Alloy Steel.* Bethlehem Steel Co. (1-117)
*Hard-Facing Metals.* Coast Metals, Inc. (1-240)
*Alloy Steels.* Peter A. Frasse & Co., Inc. (1-220)
*High Strength Steel.* Great Lakes Steel Corp. (1-2)
*High Strength Steel.* Inland Steel Co. (1-90)
*Molybdenum Cast Steels.* Molybdenum Corp. of America. (1-145)
*"S-Curves" of Alloy Steels.* United States Steel Corp. (1-257)

### CARBON STEELS

*Aluminized Steel.* American Rolling Mill Co. (1-236)
*Cold-Finished Steels.* Bliss & Laughlin, Inc. (1-206)
*Warehouse Steel.* Bernard Epps & Co. (1-216)
*Free-Machining Open-Hearth Steels.* W. J. Holliday & Co., Speed Case Plate Div. (1-263)
*Flame-Cut Steel.* Lukens Steel Co. (1-262)
*Spring Steel.* A. R. Purdy Co., Inc. (1-189)
*Steel.* Youngstown Sheet & Tube Co. (1-227)

### HIGH-SPEED STEELS

*High-Speed Steel.* H. Boker & Co., Inc. (1-226)
*Fast Machine Steels.* Monarch Steel Co. (1-95)

### STAINLESS STEELS

*Stainless Steel Identification Chart.* Carpenter Steel Co. This handy chart makes possible rapid identification of stainless steels by presenting 11 tests for separating the various types. (1-269)
*Stainless Steel.* Electro Metallurgical Co. (1-199)
*Stainless Clad Steel.* Granite City Steel Co. (1-256)

### TOOL AND DIE STEELS

*Tool Steel.* Jessop Steel Co. Typical analysis, applications and working data on rapid finishing tool steel are presented in a 4-page, pocket-size pamphlet, No. 743. (1-268)
*Tool Steel Tubing.* Bissett Steel Co. (1-265)
*Die Steels.* Latrobe Electric Steel Co. (1-149)
*Tool Steel.* Ziv Steel & Wire Co. (1-214)

### IRON AND STEELS—GENERAL

*Specialty Steel Stock List.* Crucible Steel Co. of America. (1-110)
*Electrolytic and Sponge Iron Powder.* Plastic Metals, Inc. (1-167)
*Steels.* Republic Steel Corp. (1-267)
*Steel Stock List.* Joseph T. Ryerson & Son, Inc. (1-169)

## 2. Non-Ferrous Metals

### COPPER AND ITS ALLOYS

*Bronze Worm Gear.* Ampco Metal, Inc. Engineering Data Sheet No. 122, one sheet, describes and illustrates a metal spray gun containing a worm gear made from Ampco Metal Grade 15, extruded rod. (2-260)
*Bearing Bronze.* Johnson Bronze Co. Universal bearing bronze, completely machined, is described and illustrated in a 4-page bulletin. Specifications are included. (2-262)
*Beryllium Copper Wire.* Little Falls Alloys, Inc. A one-page reprint presents data on Silvercoate beryllium copper wire, which is covered with a silver coating that reduces wear on coiling tools, decreases surface attack during hardening, etc. (2-263)
*Non-Ferrous Alloy Specification Handbook.* North American Smelting Co. This informative, 82-page handbook presents a summary of all standard and commonly used brass, bronze, copper and aluminum ingot and casting specifications, conversion tables, formulas, definitions and data, physical properties and test bars, etc. (2-258)
*Beryllium Copper.* Riverside Metal Co. Complete data on beryllium copper, including specifications and tables, are presented in a 16-page bulletin. (2-259)
*Copper Alloy Rods for Screw Machine Products.* American Brass Co. (2-171)
*Aluminum Bronze.* American Manganese Bronze Co. (2-173)
*Oxygen-free Copper.* American Metal Co., Ltd. (2-145)
*Bending Copper Tubes and Pipes.* Copper & Brass Research Assn. (2-241)
*Beryllium-Copper Wire and Strip.* Instrument Specialties Co., Inc. (2-250)
*High Strength Iron Castings.* Meehanite Research Institute. (2-264)
*Forgeable Tin-Free Bearing Metal.* Mueller Brass Co. (2-165)
*Copper and its Alloys.* Revere Copper & Brass, Inc. (2-199)
*Special Copper Alloys.* Seymour Mfg. Co. (2-101)
*Brass and Bronze.* Titan Metal Mfg. Co. (2-102)

### LIGHT METALS

*Magnesium.* American Magnesium Corp. (2-230)
*Magnesium.* Fisher Furnace Co. (2-222)
*Aluminum and Bronze.* Frontier Bronze Co. (2-232)
*Aluminum Alloy.* Oscar W. Hedstrom Corp. (2-210)
*Aluminum and Its Alloys.* Niagara Falls Smelting & Refining Corp. (2-205)
*Aluminum and Its Alloys.* Reynolds Metals Co. (2-240)

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*Lead and Tin Products.* Alpha Metal & Rolling Mills, Inc. (2-169)
*Bismuth-Lead-Tin-Cadmium Alloy.* Cerro de Pasco Corp. (2-189)
*Lead-Base Anti-Friction Alloy.* Graphitized Alloys Corp. (2-183)

### NOBLE METALS

*Industrial Silver.* American Platinum Works. (2-200)
*Silver.* Sherman & Co. (2-184)

### SPECIAL METALS

*Molybdenum and Tungsten.* American Electro Metal Corp. (2-128)
*Resistance Alloys.* Wilbur B. Driver Co. (2-167)
*Rare Metals, Alloys and Ores.* Foote Mineral Co. (2-19)
*Uses of Indium.* Indium Corp. of America. (2-124)
*Heat Transfer Through Metal Walls.* International Nickel Co., Inc. (2-186)
*Lithium and Its Alloys.* Lithaloys Corp. (2-116)
*Metal Powders.* Powder Metals & Alloys, Inc. (2-149)

*Hard Facing Alloys.* Wall-Colmonoy Corp. (2-251)

### OTHER METALS

*Non-Ferrous Test Bars.* American Smelting & Refining Co., Federated Metals Div. This 14-page bulletin presents complete information on the preparation of representative test bars. Diagrams and illustrations are included. (2-261)

## 3. Engineering Design

### ALLOY CASTINGS

*Manganese Steel for Oil Field Service.* American Manganese Steel Div., Am. Brake Shoe Co. An attractive, 16-page bulletin, No. 244-P, describes and illustrates the use of manganese steel in serving the oil fields, including brief descriptions of manganese steel sprocket wheels, drill stem bushings, etc. (3-432)

*Stainless Steel Castings.* Atlas Foundry Co., Atlas Stainless Steel Castings Div. (3-266)

*Heat Resisting Alloy.* Chicago Steel Foundry Co. (3-19)

*Stainless Castings.* Cooper Alloy Foundry Co. (3-9)

*Nickel-Chromium Alloy Castings.* Driver-Harris Co. (3-69)

*Alloy Castings.* Duraloy Co. (3-375)

*Iron Alloy Castings.* Duriron Co., Inc. (3-231)

*Nickel-Chromium Castings.* Electro Alloys Co. (3-326)

*Corrosion and Heat Resistant Castings.* Michiana Products Corp. (3-91)

*Special Alloy Castings.* Ohio Steel Foundry Co. (3-81)

*Alloy Castings.* Sterling Alloys, Inc. (3-380)

### CASTINGS—IRON, STEEL, NON-FERROUS, ETC.

*Plaster Mold Castings.* Briggs Mfg. Co., Non-Ferrous Castings Div. This 8-page bulletin presents complete data on plaster mold castings that feature unusual dimensional accuracy, exact reproduction of fine details, and attractive, as-cast surface. Illustrations are included. (3-439)

*Chain Belts.* Chain Belt Co. Bulletin No. 437, eight pages, describes chain belts made of Rex Z-Metal, a ductile ferrous cast metal with a high tensile strength. Illustrations and specifications are included. (3-435)

*Castings.* Hamilton Foundry & Machine Co. Bulletin No. 17, eight pages, discusses a study of galling, seizing and friction, and test results using various combinations of materials, including different types of Meehanite, are described and illustrated. (3-434)

*Centrifugal Castings.* Pettibone Mulliken Corp. The centrifugal process for sounder steel castings, more uniform dimensions, less machining, etc. is described and well-illustrated in a 12-page bulletin. (3-438)

*Heat Treated Aluminum Castings.* Acme Pattern & Tool Co., Inc. (3-290)

*Special Castings.* Advance Foundry Co. (3-381)

*Centrifugal Steel Castings.* American Cast Iron Pipe Co. (3-374)

*Steel Castings.* Lebanon Steel Foundry. (3-270)

*Castings.* Manufacturers Brass Foundry Co. (3-414)

*Centrifugally Cast Non-Ferrous Metals.* Shenango-Penn Mold Co. (3-339)

### DIE CASTINGS

*Die Coats.* Foundry Services, Inc. (3-208)

*Die Castings.* New Jersey Zinc Co. (3-424)

### FORGINGS

*Flat Die Forgings.* Smith-Armstrong Forge, Inc. Flat die forgings in low carbon and high-speed, high alloy steels are profusely illustrated and described in a 12-page bulletin. (3-437)

*Designing Impression Die Forgings.* Drop Forging Assn. (3-378)

*Drop, Hammer and Upset Forgings.* Kropp Forge Co. (3-279)

*Pressed and Forged Products.* Lenape Hydraulic Pressing & Forging Co. (3-211)

*Metal Forging.* Steel Improvement & Forge Co. (3-409)

*Forgings, Crankshafts, Etc.* Titusville Forge Div., Struthers-Wells Corp. (3-413)

*Steel Forgings.* Transue & Williams Steel Forging Co. (3-383)

### METAL PARTS

*Mechanical Springs.* Associated Spring Corp. (3-426)

*Welded Rings and Bands.* American Welding & Mfg. Co. (3-419)

*Metal Stampings.* Bossert Co., Inc. (3-371)

*Thermostatic Bi-Metal.* Callite Tungsten Corp. (3-427)

*Thermostatic Bi-Metal.* W. M. Chace Co. (3-178)

*Flexible Tubing and Bellows.* Chicago Metal Hose Corp. (3-377)

*Thermostatic Metals.* General Plate Div., Metals & Controls Corp. (3-181)

*Porous Bronze Bearings.* Keystone Carbon Co. (3-331)

*Sheet Metal Parts.* Kirk & Blum Mfg. Co. (3-238)

*Sheet Metal Products.* Penn Metal Corp. of Pennsylvania. (3-398)

*Wear Resistant Precious Metal Parts.* Permo, Inc. (3-65)

*In this Manufacturers' Literature INDEX, new bulletins are given complete reviews, and previously described older bulletins are merely listed in their proper places.*

*Self-Lubricating Bearings.* R. W. Rhoades Metaline Co., Inc. (3-46)

*Gilding Metal on Steel.* Superior Steel Corp. (3-341)

*Thermostat Metals and Electric Contacts.* H. A. Wilson Co. (3-70)

### NON-METALLICS

*Pressed Woods, Hardboards, etc.* Masonite Corp. This 20-page bulletin profusely illustrates and describes Masonite ligno-cellulose hardboards and insulation products, and includes numerous diagrams and specifications. (3-440)

*Gaskets and Sealing Materials.* Armstrong Cork Co. (3-255)

*Plastics.* Bakelite Corp. (3-287)

*Heat-Resistant Glass.* Corning Glass Works. (3-319)

*Plastics.* Dow Chemical Co., Plastics Div. (3-405)

*Plastic as Adhesive or Binder.* E. I. duPont de Nemours & Co., Inc., Electrochemicals Dept. (3-314)

*Plastics in Product Design.* Durez Plastics & Chemicals, Inc. (3-93)

*Plastics.* Durite Plastics, Inc. (3-382)

*Plastic Data Book.* Formica Insulation Co. (3-210)

*Plastics.* General Electric Co. (3-362)

*Synthetic Rubber.* B. F. Goodrich Rubber Co. (3-327)

*Corrosion-Resistant Equipment.* Haveg Corp. (3-271)

*Plastic Custom Molding.* Imperial Molded Products Corp. (3-389)

*Plastic Washers, Gaskets and Discs.* Industrial Products Suppliers. (3-388)

*Plastic Resin Products.* Keyes Fibre Co. (3-408)

*Plastics.* Monsanto Chemical Co., Plastics Div. (3-348)

*Carbon and Graphite Tubes.* National Carbon Co., Inc., Carbon Products Div. (3-227)

*Carbon Seal Rings.* Pure Carbon Co. (3-402)

*Plastics.* Richardson Co. (3-403)

*(Continued on Next Page)*

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*Ceramic Plastics.* Westinghouse Electric & Mfg. Co. (3-236)

### POWDER METALLURGY

*(See also Sec. 2—Special Metals; Sec. 3—Metal Parts; and Sec. 8—Metal Powder Processing)*

*Powder Metallurgy.* Powder Metallurgy Corp., Div. Gen. Bronze Co. Information on how to save time and money in the quantity production of small parts with powder metallurgy is presented in an 8-page, pocket-size folder. Illustrations of these small parts are included. (3-441)

*Porous Bronze Bearings.* Bound Brook Oil-Less Bearing Co. (3-393)
*Controlled Friction.* General Metals Powder Co. (3-404)
*Alloy Powders for Powder Metallurgy.* Unexcelled Mfg. Co., Inc. (3-379)

### TUBING

*Cold-Drawn Tubing.* Summerill Tubing Co. A 1-page reprint describes and illustrates cold-drawn tubing procedures, and briefly mentions the needs of tubing in the helicopter. (3-433)
*Tube Bending.* American Tube Bending Co., Inc. (3-396)
*Tubes and Pipes.* Babcock & Wilcox Co. (3-143)

### OTHER METAL FORMS

*Hot-Coiled Springs.* Muehlhausen Spring Corp. The forming of large hot-coiled springs is profusely illustrated and described in this 4-page booklet. (3-436)
*Curved Bars.* Cooper-Bessemer Corp. (3-410)
*Weldments.* Graver Tank & Mfg. Co., Inc. (3-425)
*Spinning and Steel Metal Parts. Gray Mfg.* Co. (3-395)
*Nails, Rivets, Etc.* John Hassall, Inc. (3-418)
*Magnet Steels.* Indiana Steel Products Co. (3-340)
*Steel Music Wire.* Johnson Steel & Wire Co. (3-351)
*Sheet Metal Fabrication.* Lyon Metal Products, Inc. (3-411)
*Metal Spinnings.* Milwaukee Metal Spinning Co. (3-397)
*Steel Stampings.* Worcester Pressed Steel Co. (3-273)

## 4. Melting • Refining • Casting

### ALLOYING AGENTS

*Aluminum Alloys.* National Smelting Co. This attractive, 16-page bulletin describes and illustrates Red-X aluminum alloys. Properties, composition and specifications are included. (4-187)
*Exothermic Alloying Agent.* Chromium Mining & Smelting Corp., Ltd. (4-47)
*Lithium Copper.* P. R. Mallory & Co., Inc. (4-55)
*Non-Ferrous Ingot Metal.* Nassau Smelting & Refining Co., Inc. (4-183)
*Foundry Alloys.* Vanadium Corp. of America. (4-170)

### AUXILIARIES

*Mulling Equipment.* Beardsley & Piper Co. This 4-page bulletin describes and illustrates the Mulbaro, a portable mulling unit specially designed for small foundries, and for special small batches in larger foundries. Specifications are included. (4-186)

*Charging Bucket.* Whiting Corp. The safety and time-saving features of the Sivyer-type charging bucket for electric furnaces are described and illustrated in a 1-page bulletin, No. FY-128. (4-185)

*Centrifugal Casting Machine.* Centrifugal Casting Machine Co. (4-180)
*Molding Sand Binder.* Hercules Powder Co. (4-103)
*Mold and Core Wash.* Refractory Mica Products, Inc. (4-107)
*Steel Melting Pots.* Swedish Crucible Steel Co. (4-171)
*Zirconite Products.* Titanium Alloy Mfg. Co. (4-173)

### REFINING AGENTS

*Metal Purifiers.* American-British Chemical Supplies, Inc. (4-156)
*Desulphurizing Agent.* Mathieson Alkali Works, Inc. (4-111)
*Granular Soda Ash.* Solvay Sales Corp. (4-182)

### MELTING FURNACES AND PARTS

*Rocking Electric Furnace.* Detroit Electric Furnace Div., Kuhlman Electric Co. Bulletin No. 432, 24 pages, describes and illustrates a rocking electric furnace for melting brass, bronze, copper, zinc, nickel, special irons and steels, etc. (4-188)

*High Frequency Furnaces.* Ajax Electrothermic Corp. (4-60)
*Induction Furnaces for Aluminum Alloys.* Ajax Engineering Corp. (4-95)
*Proper Melting in the Foundry.* Ajax Metal Co. (4-81)
*Electric Furnaces.* American Bridge Co. (4-82)
*Laboratory Crucible Furnace.* Campbell-Hausfeld Co. (4-105)
*Cutting Crucible Costs.* Crucible Manufacturers' Assn. (4-36)
*Recuperative Open Hearth Furnaces.* Fitch Recuperator Co. (4-101)
*Regenerative Furnace System.* Morgan Construction Co. (4-72)

### RAW MATERIALS

*Production of Silvery Pig Iron.* Jackson Iron & Steel Co. (4-91)

## 5. Heating • Heat Treatment

### ATMOSPHERES AND GENERATORS

*$SO_2$ in Magnesium Industry.* Ansul Chemical Co. (5-379)
*Anhydrous Ammonia.* Armour Ammonia Works. (5-435)
*Atmosphere for Treating Metals.* Drever Co. (5-220)
*Control of Furnace Atmosphere.* C. I. Hayes, Inc. (5-33)
*Drying Air or Gases.* Pittsburgh Lectrodryer Corp. (5-500)

### AUXILIARIES

*Infra-Red Burners.* Burdett Mfg. Co. (5-427)
*Coating of Quenching Tanks.* Carrier Corp. (5-511)
*Atmosphere Indicator.* Claud S. Gordon Co. (5-437)
*Industrial Sub-Zero Machines.* Kold-Hold Mfg. Co. (5-328)
*Cold-Treating Equipment.* Motor Products Corp., Deep-Freeze Div. (5-410)
*Heat Exchanger for Metallurgical Operations.* Niagara Blower Co. (5-293)
*Sub-Zero Chest.* Revco, Inc. (5-350)
*Valves.* W. S. Rockwell Co., Blast Gate Valve Div. (5-509)
*Oil Coolers.* Sims Co. (5-508)
*Steel Hardening Solution.* Steeltem Chemical Co. (5-477)
*Quenching Oil Coolers.* Whitlock Mfg. Co. (5-318)
*Metal Conveyor Belts.* Wickwire Spencer Steel Co. (5-331)

### BATHS AND COMPOUNDS

*Salt Bath Furnaces.* Ajax Electric Co., Inc. (5-489)
*Case Hardening.* American Cyanamid & Chemical Corp. (5-459)
*Heat Treating Baths.* Heatbath Corp. (5-460)
*Neutral Baths.* A. F. Holden Co. (5-498)
*Salt Bath Material.* E. F. Houghton & Co. (5-402)
*Carburization Check.* Park Chemical Co. (5-351)
*Heat Treating Salts.* G. S. Rogers & Co. (5-501)

### BURNERS

*Burners.* Bloom Engineering Co. (5-439)
*Infra-Red Ray Burner.* Carbomatic Corp. (5-398)
*Gas Appliances.* Johnson Gas Appliance Co. (5-286)
*Pre-Mixing Burners.* C. M. Kemp Mfg. Co. (5-257)
*Oil Burners.* National Airoil Burner Co., Inc. (5-468)
*Oil Burning System.* Peabody Engineering Corp. (5-312)
*Superheat Burners.* Selas Corp. of America. (5-394)

### ELECTRICAL HARDENING AND HEATING

*Electric Forging Heaters.* American Car & Foundry Co. (5-23)
*Heat Treating and Brazing.* Eastern Heat Treating & Brazing Corp. (5-502)
*Industrial Electric Heating.* General Electric Co. (5-301)
*Induction Heating Data Sheets.* Induction Heating Corp. (5-299)
*Induction Heating Equipment.* Lepel High Frequency Laboratories, Inc. (5-355)
*High Frequency Induction Heating.* Ohio Crankshaft Co. (5-488)

### FURNACES

*Blowerless Furnace.* Mahr Mfg. Co. Bulletin No. 260, two pages, describes and illustrates a blowerless furnace that controls temperatures up to 1900 F. Specifications are included. (5-518)

*Industrial Electric Furnaces.* Sentry Co. Bulletin No. 1010-1, four pages, describes and

illustrates the standard Model H industrial electric furnaces for annealing, preheating, enameling, etc. (5-519)

*Forced Convection Furnaces.* Surface Combustion Div., General Properties Co., Inc. The heat treatment of light metals in a variety of forced convection furnaces is described and profusely illustrated in an 8-page bulletin. (5-517)

*Electric Pot Furnaces.* American Electric Furnace Co. (5-97)

*Blowerless Furnaces.* Baker & Co., Inc. (5-168)

*Industrial Furnaces.* Chicago Flexible Shaft Co. (5-159)

*Industrial Furnaces.* Dempsey Industrial Furnace Co. (5-342)

*Bright Annealing.* Electric Furnace Co. (5-44)

*Rotary Forging Furnaces.* George J. Hagan Co. (5-265)

*Carburizing Equipment.* Hevi-Duty Electric Co. (5-294)

*Heat-Treat Furnaces.* Charles A. Hones, Inc. (5-415)

*Heat Treating and Laboratory Furnaces.* K. H. Huppert. (5-303)

*Portable Rivet Heaters.* Charles F. Kenworthy, Inc. (5-317)

*Heat Treating Furnaces.* Leeds & Northrup Co. (5-504)

*Heat-Treat Furnace.* Lindberg Engineering Co. (5-403)

*Bright Gas Carburizing.* Lithium Corp. (5-211)

*Forced Convection Tempering Furnaces.* Morrison Engineering Corp. (5-308)

*Car Hearth Furnaces.* R-S Products Corp. (5-392)

*Electric and Fuel Car-Type Furnaces.* W. S. Rockwell Co. (5-298)

*Gas Fired Oven Furnaces.* Rolnick Testing & Mfg. Co. (5-175)

*Heat Treating Furnaces.* Salem Engineering Co. (5-341)

*Electric Salt Bath Furnaces.* Upton Electric Furnace Div., Commerce Pattern Foundry & Machine Co. (5-295)

*Induction Heating Units.* Van Norman Co. (5-396)

*Heat Treating Furnaces.* Vulcan Corp. (5-368)

### OVENS

*Foundry Ovens.* Despatch Oven Co. Bulletin No. 32, four pages, describes and illustrates the Coremaster drawer-type foundry ovens for core baking, mold drying and pasting. Specifications are included. (5-520)

*Electrically-Heated Ovens.* Harold E. Trent Co. Bulletin No. 71-T, 12 pages, presents the complete line of electrically-heated ovens. Applications, specifications and illustrations are included. (5-521)

*Air Heaters.* J. O. Ross Engineering Corp. (5-374)

### PROCESSES

*Heat Treating High-Speed Steel Tools.* Bennett Steel Treating Co. The Nitron process of heat treating tungsten, molybdenum and cobalt types of high-speed steel tools is presented in a 4-page, pocket-size folder. (5-522)

*Bright Hardening.* Alfred Heller Heat Treating Co. (5-269)

*Surface Hardening Stainless Steel.* Industrial Steels, Inc. (5-422)

*The Nitriding Process.* Nitralloy Corp. (5-278)

*Heat Treating High Speed Tool Steels.* Tuff-Hard Corp. (5-280)

## 6. Refractories • Insulation

*Refractories.* Illinois Clay Products Co. This 4-page folder briefly describes and illustrates the production of Goose Lake fire clay and brick, and cupola block. (6-156)

*Refractory Bonding Mortar.* Ironton Fire Brick Co. A 1-page reprint describes and illustrates "Ironton Berlite", a super-quality refractory bonding mortar for use in foundries. (6-158)

*Protective Coating.* Geo. R. Mowat Co. Complete information on Griffin's Hytemp protective coating that resists temperatures up to 3500 F. on refractory material, graphite, crucibles, etc. is presented in a 4-page folder. (6-157)

*Silicon-Carbide Refractories.* American Crucible Co. (6-145)

*Furnace Wall Coatings.* Armor-Clad Co. (6-126)

*Heat Transmission.* Atlas Lumnite Cement Co. (6-136)

*Pipe Insulation.* Baldwin-Hill Co. (6-144)

*Plastic Refractory.* Basic Refractories, Inc. (6-151)

*Suspension Arches.* Bigelow-Liptak Corp., Div. A. P. Green Firebrick Co. (6-131)

*Plastic Super-Cement.* Botfield Refractories Co. (6-94)

*Refractory Coating Material.* Brickseal Refractory Co. (6-67)

*Heavy Duty Refractories.* Carborundum Co., Refractory Div. (6-45)

*Masonry Saw.* Clipper Mfg. Co. (6-82)

*Flux Resistant Refractory.* Corhart Refractories Co. (6-95)

*Insulation.* Eagle-Picher Lead Co. (6-140)

*Stopper Heads.* Electro Refractories & Alloys Corp. (6-84)

*Diatomite.* Johns-Manville Corp. (6-134)

*Rotary Kiln Lining.* Laclede-Christy Clay Products Co. (6-79)

*Super-Refractories Products.* Mullite Refractories Co. (6-75)

*Firebrick.* Plibrico Jointless Firebrick Co. (6-129)

*Insulating Refractory Concrete.* Quigley Co., Inc. (6-18)

*Refractories and Insulation.* Refractory & Insulation Corp. (6-135)

*Refractories for Aluminum.* Charles Taylor Sons Co. (6-133)

*Silica Tubing and Rod.* Thermal Syndicate, Ltd. (6-103)

## 7. Welding

### BRAZING AND SOLDERING

*Silver Brazing Alloy.* Handy & Harman. Complete information on how to repair broken cutting tools with Easy-Flo, a low-temperature silver brazing alloy, is presented in Bulletin No. 14, well illustrated, containing 16 pages. (7-290)

*Brazing.* Gasflux Co. (7-280)

*Solders and Fluxes.* Kester Solder Co. (7-116)

*Fluxless Solder.* Metalloy Products Co. (7-258)

*Silver Flux.* Scaife Co. (7-224)

*Soldering, Brazing Flux.* Special Chemicals Corp. (7-67)

*Phos-Copper Brazing.* Westinghouse Electric & Mfg. Co. (7-204)

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### ELECTRIC ARC WELDING

*Stud Welder.* Nelson Specialty Welding Equipment Corp. A six-page reprint features the stud welder and its manufacture. Interesting illustrations are included. (7-292)

*Arc Welding Tool and Die Steels.* C. E. Phillips & Co. An interesting, 16-page bulletin presents complete data on arc welding in the maintenance and construction of tools and dies. Numerous illustrations, graphs, tables and specifications are included. (7-291)

*Welding Stainless Steels.* Alleghany Ludlum Steel Corp. (7-247)

*Stainless Steel Electrodes.* Alloy Rods Co. (7-235)

*Electrodes.* American Agile Corp. (7-233)

*Electrode Color Chart.* Arcos Corp. (7-78)

*Welding Electrodes.* Anthony Carlin Co. (7-286)

*Arc Welding Accessories.* General Electric Co. (7-188)

*Austenitic Stainless Steel Electrodes.* Harnischfeger Corp. (7-110)

*Arc Welding.* Hobart Brothers Co. (7-147)

*Arc Welding Inspection Chart.* Lincoln Electric Co. (7-270)

*Shielded Arc Welding Electrodes.* McKay Co. (7-21)

*Arc Welding Electrodes.* Metal & Thermit Corp. (7-47)

*Arc Starting Machine.* Mid-States Equipment Co. (7-234)

*Stainless Steel Welding Wire.* Page Steel & Wire Div., American Chain & Cable Co. (7-93)

*Reclaiming High-Speed Tools.* Welding Equipment Supply Co. (7-166)

*A. C. Welders.* Westinghouse Electric & Mfg. Co. (7-156)

### FLAME PROCESSING

*Progress in Flame Processing.* Air Reduction Co. (7-100)

*Oxyacetylene Welding and Cutting.* Linde Air Products Co. (7-75)

### GAS WELDING

*Low Temperature Welding Rods.* Eutectic Welding Alloys Co. Complete data on Eutectic low temperature welding rods are presented in an 8-page bulletin. Illustrations and a rod selector table are included. (7-288)

*Bronze-Welding Alloys.* Bridgeport Brass Co. (7-79)
*Preventing Welding and Cutting Fires.* International Acetylene Assn. (7-246)
*Flux Chart.* Krembs & Co. (7-267)

### RESISTANCE WELDING

*Current Interrupter.* Sciaky Brothers. Bulletin No. 201-A describes the Dynatrol, a new device for the high-speed, arcless current interruption of inductive d.c. circuits. (7-293)

*Steel Grating.* Blaw-Knox Div. (7-249)
*Resistance Welder Control.* General Electric Co. (7-150)
*Resistance-Welder Control.* Weltronic Co. (7-285)

### SUPPLIES

*Regalvanized Welds.* Galv-Weld Products. Complete instructions for the use of Galv-Weld Alloy for regalvanizing welds is presented in two pages. Prices and shipping information are included. (7-289)

*Welding and Cutting Equipment.* Victor Equipment Co. An attractive 16-page catalog describes and profusely illustrates a variety of welding and cutting equipment, including safety regulators, cutting units, etc. Prices are included. (7-287)

*Welding and Brazing Fluxes.* American Products Corp. (7-272)
*Welding Positioners.* Bentley Weldery, Inc. (7-217)
*Welding Positioners.* Cullen-Friestedt Co. (7-220)
*General Utility Torches.* Insto-Gas Corp. (7-175)
*Welding Positioners.* Lyon-Raymond Corp. (7-216)
*Pressure Gage.* Manning, Maxwell & Moore, Inc., Ashcroft Gage Div. (7-279)
*Fume Collectors.* Ruemelin Mfg. Co. (7-228)
*Welding Electrodes.* A. O. Smith Corp. (7-261)

## 8. Metal-Working

### FORMING

*Hydraulic Presses.* Hydraulic Press Mfg. Co. This 32-page bulletin, No. 4400, describes and illustrates the H-P-M "Closed Circuit" Fastraverse system of hydraulic press operation. Numerous illustrations and diagrams are included. (8-457)

*Presses.* Cleveland Crane & Engineering Co. This highly illustrated, 8-page bulletin, No. 2010-A, describes Steelweld presses for bending, braking, punching, blanking, etc. (8-458)

*Rotary Shears.* Kling Bros. Engineering Works. This 8-page, illustrated bulletin describes six sizes of rotary shears for cutting or forming straight lines, circles, rings, bevels, flanges, etc. Specifications are included. (8-459)

*Hydraulic Presses.* Watson-Stillman Co. Bulletin No. 370A, four pages, describes and illustrates general purpose hydraulic presses suitable for diversified work in the metal-forming, ceramic or plastic industries. Specifications are included. (8-461)

*Self-Contained Hydraulic Presses.* Baldwin-Southwark Div. (8-65)
*Oil Hydraulics.* Denison Engineering Co. (8-307)
*Straightening and Other Presses.* A. B. Farquhar Co., Ltd. (8-75)
*Presses.* Ferracute Machine Co. (8-376)
*Metal Extrusion Press.* Hydropress, Inc. (8-210)

*Double-Flaring Tool.* Imperial Brass Mfg. Co. (8-348)
*Hydraulic Presses.* Lake Erie Engineering Corp. (8-248)
*Die-Casting Machines.* Reed-Prentice Corp. (8-273)
*Extrusion Presses.* Schloemann Engineering Corp. (8-306)
*Hole-Punching Assembly.* Wales-Strippit Corp. (8-410)
*Turret Punch Presses.* Wiedemann Machine Co. (8-213)

### FORGING

*Swaging Machine.* Standard Machinery Co. (8-343)

### MACHINING

*Tool Bit Grinding Fixture.* Boyar-Schultz Corp. A 2-page bulletin describes and illustrates the Model G Universal tool bit grinding fixture for grinding both right and left hand tool bits. (8-452)

*Standard Carbide Tools.* Carboloy Co., Inc. Catalog No. GT-175, 30 pages, presents a complete line of standard tools, carbide form tools and "Semi-Standard" tools. Prices and specifications are included. (8-464)

*Metal Cutting Machines.* De Walt Products Corp. This 4-page bulletin describes and illustrates two metal cutting machines for wet and dry cutting, and includes specifications. (8-456)

*New Industrial Tools.* DoAll Service Co. A complete line of new DoAll industrial tools, including cutting machines, speed controls, hydraulic presses, etc., is presented in a 36-page booklet, profusely illustrated. (8-455)

*Carbide Tips and General Purpose Tools Price List.* Firth-Sterling Steel Co. This 4-page bulletin, No. FE-110, presents a price list, effective March 1, 1944, of sintered carbide tips and general purpose tools. Illustrations are included. (8-453)

*Cutting Tools.* Haynes Stellite Co. Star J-Metal cutting tools are described and illustrated in a 16-page bulletin. Prices and specifications are included. (8-463)

*Carbide-Tipped Centers and Reamers.* New England Carbide Tool Co., Inc. Specifications and prices of carbide-tipped reamers and Morse taper and Brown & Sharpe taper carbide-tipped centers are presented in a 2-page bulletin. (8-454)

*Air Grinders.* Madison-Kipp Corp. This 8-page folder describes and illustrates Kipp air grinders, featuring the patented air-saving Kipp Speed Governor. (8-462)

*Carbide-Tipped Cutting Tools.* Wendt-Sonis Co. Catalog No. 144, 48 pages, illustrates a complete line of cemented carbide-tipped cutting tools. Specifications and list prices are included. (8-460)

*Collet Chucks.* Aircraft Machinery Corp. (8-400)
*Tool Shanks and Cutter Bodies.* Am. Brake Shoe Co., Brake Shoe & Castings Div. (8-361)
*Cutting Machine.* Am. Chain & Cable Co., Andrew C. Campbell Div. (8-433)
*Metal-Working Oils.* F. E. Anderson Oil Co. (8-396)
*Oil Clarifiers.* Briggs Clarifier Co. (8-382)
*Grinding Wheel Dressers and Cutters.* Calder Mfg. Co. (8-371)
*Coated Abrasives.* Carborundum Co., Globar Div. (8-366)
*Thread Tool Grinding Fixtures.* Robert H. Clark Co. (8-330)
*Automatic Tapping.* Cleveland Tapping Machine Co. (8-411)
*Oil Filters.* Cuno Engineering Corp. (8-108)
*Salvaging Oil.* De Laval Separator Co. (8-337)
*Cut-Off Machines.* A. P. de Sanno & Son, Inc. (8-232)
*Machine Tools.* Gisholt Machine Co. (8-352)
*Portable Coolant Systems.* Gray-Mills Co. (8-364)
*Cutting Oil.* Gulf Oil Corp. (8-141)
*Demagnetizer for Metal Working Shops.* Ideal Commutator Dresser Co. (8-109)
*Portable Electric Tools.* Independent Pneumatic Tool Co. (8-259)
*Diamond Bonded Wheels.* Industrial Abrasives, Inc. (8-380)
*Dressing of Abrasive Wheels.* J. & S. Tool Co. (8-270)
*Cemented Carbides.* Kennametal Inc. (8-301)
*Reclamation System.* National Chipveyor Systems. (8-169)
*Semi-Automatic Burring Machine.* Pines Engineering Co., Inc. (8-183)
*Machining of Stainless Steel.* Rustless Iron & Steel Corp. (8-211)
*Metal Cutting Oils.* Shell Oil Co., Inc. (8-367)
*Soluble Cutting Oil.* D. A. Stuart Oil Co., Ltd. (8-450)

### ROLLING

*Bending Rolls.* Buffalo Forge Co. (8-74)
*Solid Steel Shear Knives.* Heppenstall Co. (8-224)

### METAL POWDER PROCESSING

*Conical Mills.* Hardinge Co. (8-144)
*Presses for Powdered Metals.* Kux Machine Co. (8-62)
*Batch Mixers.* Lancaster Iron Works, Inc. (8-129)
*Powder Mixing Machines.* National Engineering Co. (8-92)
*Metal-Powder Mixers.* Patterson Foundry & Machine Co. (8-114)
*Powder Metallurgy Presses, Molds.* F. J. Stokes Machine Co. (8-54)

### RIVETING AND FASTENING

*Screws, Bolts, Nuts, Etc.* Aluminum Co. of America. (8-442)
*Locking System.* Bardwell & McAlister, Inc. (8-374)
*Blind Riveting.* Cherry Rivet Co. (8-451)

## 9. Cleaning • Finishing

### CLEANING

*Metal Cleaner.* American Chemical Paint Co. Technical Data Sheet No. P-100-5, four pages, presents complete information on the Deoxidine Process for salvaging 20- and 40-mm. projectiles and for the cleaning and treatment of not visibly rusted projectiles. (9-410)

*Industrial Cleaning Machines.* Alvey-Ferguson Co. (9-251)
*Degreasers.* American Foundry Equipment Co. (9-233)
*Cleaning Compounds.* Apex Alkali Products Co. (9-333)
*Tumbling Equipment.* Baird Machine Co. (9-383)
*Electrochemical Descaling.* Bullard-Dunn Div., Bullard Co. (9-88)
*Rotating Barrels.* Dreisbach Engineering Corp. (9-407)
*Metal Washing Machines.* Howard Engineering & Mfg. Co. (9-305)
*Pre-Cleaning for Plating.* Macdermid, Inc. (9-110)
*Metal Cleaning in War Time.* Magnus Chemical Co. (9-146)
*Cleaning Compounds.* Magnuson Products Corp. (9-254)
*Metal Washing Machines.* Metalwash Machinery Co., Inc. (9-306)
*Preparation for Oxide Finishing.* Oakite Products, Inc. (9-264)
*Heavy-Duty Cleaning of Ferrous Metals.* Pennsylvania Salt Mfg. Co. (9-129)
*Cleaning Equipment for Metals.* N. Ransohoff, Inc. (9-230)
*Metal Cleaning.* Solventol Chemical Products, Inc. (9-216)
*Plater's Cleaner.* Turco Products, Inc. (9-211)
*Abrasive Cleaning.* Vapor Blast Mfg. Co. (9-166)

### CHEMICAL TREATMENTS

*Oxide Coating on Metals.* Alrose Chemical Co. (9-167)
*Gun Metal Finish.* American Gas Furnace Co. (9-238)
*Steel Finishing.* Du-Lite Chemical Corp. (9-258)
*Blackening Aluminum.* Enthone Co. (9-278)
*Chemicals for Protecting and Coloring Metal Surfaces.* Mitchell-Bradford Chemical Co. (9-152)
*Rust-Proofing.* Parker Rust Proof Co. (9-334)
*Black Oxide Finishes.* Tobler Chemical Co. (9-336)

### ELECTROPLATING

*Copper Plating.* United Chromium, Inc. Unichrome alkaline copper plating for fast production of smooth, ductile deposits, is described and illustrated in a 6-page folder. (9-413)

*Plating Solution Filtration.* Alsop Engineering Corp. (9-101)
*Corrosion Inhibitor.* Angier Corp. (9-390)
*Selenium Rectifiers.* W. Green Electric Co., Inc. (9-321)
*Rectifiers.* Hanson-Van Winkle-Munning Co. (9-226)
*Chromium Plating.* Industrial Chromium Corp. (9-303)
*Electroplating Equipment.* Munning & Munning, Inc. (9-308)

### METALLIC COATINGS (NON-ELECTROLYTIC)

*Metal Spray Equipment.* Metallizing Co. of America, Inc. (9-371)
*Metallizing.* Metallizing Engineering Co., Inc. (9-409)
*Corrosion-Resistant Metal Coating.* Standard Steel Spring Co., Corronizing Div. (9-394)

### NON-METALLIC AND ORGANIC COATINGS

*Synthetic Coating.* Cordo Chemical Corp. Technical bulletin No. 21, one page, presents data on a synthetic coating, type No. 2, and includes baking schedules and application procedures. (9-411)

*Corrosion-Resistant Coatings.* Carbozite Corp. (9-202)
*Infra-Red Drying.* Fostoria Pressed Steel Corp. (9-221)
*Paints.* S. C. Johnson & Son, Inc. (9-270)
*Protective Coatings.* M. W. Kellogg Co. (9-253)
*Protective Coating.* Rheem Research Products, Inc. (9-355)
*Spray Finish Machines.* Spray Engineering Co. (9-182)

### PICKLING

*Tanks.* Tivit Products Co. This 8-page bulletin describes and illustrates a variety of tanks, made of steel, lead-lined steel, stainless steel, Monel metal, glass-lined steel, or copper, for degreasing, pickling, galvanizing, tinning, etc. (9-412)

*Corrosion Resistant Ceramics.* Atlas Mineral Products Co. (9-72)
*Dipping Baskets.* C. O. Jelliff Mfg. Corp. (9-245)
*Pickling and Plating Tanks.* Maurice A. Knight. (9-378)
*Ferric Sulphate and Cartridge Cases.* Monsanto Chemical Co., Merrimac Div. (9-176)
*Processing Carriers.* Rolock, Inc. (9-382)
*Welded Equipment for Pickling, Annealing, Etc.* Youngstown Welding & Engineering Co. (9-381)

### POLISHING

*Polishing and Buffing Equipment.* Frederic B. Stevens, Inc. Catalog No. 27, 36 pages, presents a complete line of materials and methods for polishing, buffing and deburring operations. Numerous illustrations and specifications are included. (9-414)

*Cleaner.* Industrial Power & Equipment Co. (9-368)
*Greaseless Abrasive Compound for Burring.* Lea Mfg. Co. (9-142)
*Magnetic Polishing Lathes.* Lima Electric Motor Co. (9-400)
*Coated Abrasives.* Norton Co., Behr-Manning Div. (9-318)
*Grinders and Buffers.* Queen City Machine Tool Co. (9-404)

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## 10. Testing • Quality Control

### CONTROL INSTRUMENTS

*Recording, Indicating and Controlling Instruments.* Bristol Co. A complete listing of this company's products and trade names is presented in five pages. (10-528)

*Flow Rate Meters.* Fischer & Porter Co. Complete data on Rotameter flow rate meters are presented in a 32-page catalog, No. 10-B. Numerous illustrations and graphs are included. (10-523)

*Electrical Control Motors.* Automatic Temperature Control Co. (10-430)
*Relays.* Barber-Colman Co. (10-331)
*Measuring, Controlling Furnace Atmospheres.* Brown Instrument Co. (10-285)
*Heat Controls.* Burling Instrument Co. (10-307)
*Combustion Control.* Cities Service Oil Co. (10-518)
*Flame-Failure Safeguard.* Combustion Control Corp. (10-502)
*Flue Gas Analyzer.* Charles Engelhard, Inc. (10-143)
*Potentiometer Indicators.* Foxboro Co. (10-251)
*Open-Hearth Furnace Control.* Hays Corp. (10-425)
*Pyrometers.* Illinois Testing Laboratories, Inc. (10-483)
*Rheostats.* Ohmite Mfg. Co. (10-356)
*Measuring Furnace Gases.* Permutit Co. (10-195)
*Immersion Pyrometer.* Pyrometer Instrument Co. (10-8)
*Recording Charts.* C. J. Tagliabue Mfg. Co. (10-196)
*Industrial Heating Units and Controls.* Westinghouse Electric & Mfg. Co. (10-220)
*Temperature Control on Tunnel Kilns.* Wheelco Instruments Co. (10-276)

### HARDNESS TESTING

*Microhardness Testers.* Eberbach & Son Co., Inc. (10-393)
*Portable Brinell Hardness Tester.* Andrew King. (10-148)
*Hardness Testing Machines.* Riehle Testing Machine Div., Am. Machine & Metals, Inc. (10-384)
*Hardness Conversion Tables.* Wilson Mechanical Instrument Co. (10-92)

### INSPECTION DEVICES

*Dial Indicators.* B. C. Ames Co. This 2-page bulletin briefly describes and illustrates four hundred-series dial indicators, and includes specifications. (10-522)

*Precision Instruments.* Continental Machines, Inc. This highly-illustrated, 24-page bulletin presents a variety of DoAll gages and gage instruments for precision measurement in micro-inches. Specifications are included. (10-526)

*Fan Scales.* Detecto-Gram Scales Div., Detecto Scales, Inc. A single sheet describes and illustrates two industrial fan scales that save labor, time and money, and give accurate weights instantly. (10-521)

*Electronic Metal Identifier.* Allen B. Dumont Laboratories, Inc. This 20-page bulletin describes and illustrates the Cyclograph, an

electronic metal identifier for conducting non-destructive metallurgical examinations for production-quality control. (10-529)

*Gage Blocks.* Fonda Gage Co. Eight important points in selecting gage blocks are discussed in a 4-page bulletin. Illustrations and specifications are included. (10-531)

*Surface-Roughness Measurement.* Physicists Research Co. Practical surface-roughness measurement with the Type Q Profilometer is described in an attractive, well-illustrated 12-page bulletin. (10-524)

*Inspection and Control of Surface Finish.* George Scherr Co. The Spencer binocular microscope for the inspection and control of surface finish is described and illustrated in a 4-page bulletin. Specifications are included. (10-525)

*Measuring Coating Thickness.* American Instrument Co. (10-118)
*Angle Computer.* Angle Computer Co. (10-396)
*Surface Smoothness Tester.* Brush Development Co. (10-192)
*Hook Checker.* Detroit Tap & Tool Co. (10-471)
*Identification of Steel.* Dravo Corp. (10-271)
*Blind Hole Gages.* Federal Products Corp. (10-452)
*pH Meters.* Gamma Instrument Co. (10-334)
*Sheet Metal Dial Micrometers.* Haines Gauge Co., Inc. (10-140)
*Magnaflux.* Magnaflux Corp. (10-288)
*Indicating Gages.* Metrical Laboratories, Inc. (10-504)
*Illuminated Magnifiers.* E. W. Pike & Co. (10-345)
*Microscopic Comparators.* Portman Machine Tool Co. (10-332)
*Surface Plates.* State Mfg. & Construction Co. (10-508)
*Abrasive Wear Tests.* Taber Instrument Co. (10-233)

## MECHANICAL TESTING

*Tensile Tester.* W. C. Dillon & Co., Inc. Bulletin No. 141, eight pages, describes and illustrates the Model K tensile tester for precision testing. (10-527)

*Strain Gages.* Baldwin-Southwark Div. (10-341)
*Testing Machines for Plastics.* Tinius Olsen Testing Machine Co. (10-252)
*Tensile Testing of Fine Wire.* Henry L. Scott Co. (10-55)

## METALLOGRAPHIC EQUIPMENT

*Optical Instruments.* Bausch & Lomb Optical Co. (10-357)
*Metallurgical Testing Apparatus.* Adolph I. Buehler. (10-80)
*Data on Electron Microscope.* R.C.A. Manufacturing Co. (10-302)

## RADIOGRAPHY

*Films for Industrial Radiography.* Ansco. (10-278)
*X-Ray Protection and Light Proofing.* Bar-Ray Products. (10-509)
*Industrial Radiography with Radium.* Canadium Radium & Uranium Corp. (10-515)
*Laboratory Equipment.* Central Scientific Co. (10-507)
*X-Ray Film.* Eastman Kodak Co. (10-170)
*The X-Ray in Industry.* General Electric X-Ray Corp. (10-10)
*Industrial X-Ray.* Kelley-Koett Mfg. Co., Inc. (10-185)
*X-Ray Diffraction Tubes.* Machlett Laboratories. (10-300)
*X-Ray Apparatus.* North American Philips Co., Inc. (10-466)
*Flexible Film Holders.* Picker X-Ray Corp. (10-469)
*Laboratory Utilities.* Precision Scientific Co. (10-462)
*X-Ray Protection.* Ray Proof Corp. (10-478)
*X-Ray Machine.* Standard X-Ray Co. (10-299)

## SPECTROGRAPHY

*Universal Spectrophotometers.* Wilkens-Anderson Co. (10-180)

## LABORATORY AIDS

*Carbon and Sulphur Determinator.* Harry W. Dietert Co. A two-minute carbon determinator and a three-minute sulphur determinator are described and illustrated in an 8-page bulletin. Specifications are included. (10-530)

*High-Speed Electrolytic Analysis.* E. H. Sargent & Co. (10-219)
*Chemical Stoneware.* U. S. Stoneware Co. (10-339)

# 11. Equipment and Machinery, General

*Communication Systems.* Executone, Inc. A two-way private or amplified communication system for office, factory and military use is described and illustrated in a 4-page bulletin. (11-214)

*Installation Accessories.* J. N. Fauver Co., Inc. Bulletin No. 17-A, 16 pages, describes and illustrates numerous installation accessories for lubrication, hydraulic, steam, liquid and air applications. Specifications are included. (11-220)

*Speed Control.* General Electric Co. Complete data on the Thy-mo-trol, an electronic drive for providing and controlling adjustable-voltage power, are presented in a 40-page, illustrated catalog, No. 4025. (11-215)

*Compressors and Vacuum Pumps.* Ingersoll-Rand Co. This 32-page catalog describes and illustrates a variety of compressors and vacuum pumps in sizes from ½ to 10 h.p. (11-221)

*Impregnating Castings.* Jackson & Church Co. J & C autoclaves in a wide variety of types and sizes for impregnating castings for reclamation purposes are described and illustrated in a 4-page bulletin, No. 244. (11-222)

*Lubricants.* Sinclair Oil Corp. This attractive, 38-page catalog presents a complete line of lubricating products, and profusely illustrates their use in both war and peacetime. (11-217)

***Please Use the Coupon on Page 1529***

*Air Processing Equipment.* Peters-Dalton, Inc. This attractive, 56-page catalog presents a variety of air processing equipment, including dust collecting units and systems, spray booths and equipment, ovens, etc. Numerous tables, graphs and illustrations are included. (11-218)

*Portable Sump Tank.* Spencer Turbine Co. Bulletin No. 130, four pages, describes and illustrates the new Sump-Vac sump cleaner, which cleans machine sump tanks in 2 to 10 min. Specifications are included. (11-219)

*Proper Lubrication.* Sun Oil Co., Industrial Products Dept. This large wall chart presents complete instructions on the correct procedures for proper lubrication. (11-216)

*Colloidal Graphite.* Acheson Colloids Corp. (11-147)
*Air Blowers.* Allen Billmyre Corp. (11-89)
*Centrifugal Pumps.* Allis-Chalmers Mfg. Co. (11-90)
*Air Filtration.* American Air Filter Co., Inc. (11-62)
*Pulverized Coal.* Amsler-Morton Co., Inc. (11-162)
*Mounted Wheels for Portable Tools.* Chicago Wheel & Mfg. Co. (11-70)
*Magnets and Magnetic Separators.* Dings Magnetic Separator Co. (11-49)
*Packaging Material.* Dow Chemical Co. (11-195)
*Coolant Cooler.* Frostrode Products. (11-174)
*Chemicals for the Metalworker.* Glyco Products Co., Inc. (11-137)
*Methods for Waste Reduction.* Alexander Hamilton Institute. (11-187)
*Hydraulic Equipment.* Hydraulic Machinery, Inc. (11-201)
*Vacuum Pumps.* Kinney Mfg. Co. (11-112)
*Dispatch Tubes.* Lamson Corp. (11-168)
*Conditioning Compressed Air.* Logan Engineering Co. (11-134)
*Industrial Mixers.* Mixing Equipment Co., Inc. (11-180)
*Graphite Lubricant.* National Graphite Co., Inc. (11-67)
*Paper Label Paste.* Paisley Products, Inc. (11-166)
*Dust Collector.* Pangborn Corp. (11-202)
*Hydraulic Cable Stretchers.* Parker Appliance Co. (11-173)
*Acid Proof Cement.* Pennsylvania Salt Mfg. Co. (11-71)
*Silicates.* Philadelphia Quartz Co. (11-145)
*Centrifugal Blowers.* Roots-Connersville Blower Corp. (11-102)
*Coolers.* Ross Heater & Mfg. Co., Inc. (11-181)
*Magnesium Fire Extinguishers.* St. Regis Paper Co. (11-163)
*Fabricated Metal Products.* Stanwood Corp. (11-208)
*Dust Collectors.* Torit Mfg. Co. (11-190)
*Dust Collector.* U. S. Hoffman Machinery Corp., Filtration Div. (11-210)
*Lubricants.* Warren Refining & Chemical Co. (11-87)
*Cooling and Conditioning Equipment.* Westinghouse Electric Elevator Co., Air Conditioning Div. (11-213)
*Oil Purifiers.* Youngstown Miller Co. (11-165)

# METALLURGICAL ENGINEERING news

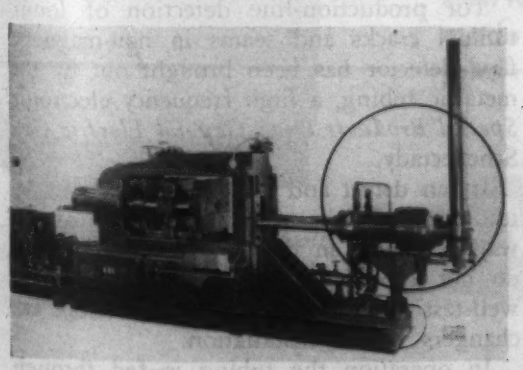
*Equipment • Finishes • Materials • Methods • Processes • Products*
*Alloys • Applications • Designs • People • Plants • Societies*

## "Pre-Fill" for Die Caster

A new "pre-fill" injection system that eliminates the necessity for hydraulic accumulators on die casting machines and greatly improves quality has been designed by *Lester Engineering Co.* for *Lester-Phoenix,* 2711 Church Ave., Cleveland 13.

Aluminum, brass and magnesium die castings can now be produced relatively free of porosity, hence suitable for critical stress loaded applications where die castings were not heretofore accepted.

It eliminates the use of a hydraulic accumulator bottle, which is a pressure vessel and dangerous because of possible careless introduction of oxygen instead of nitrogen. It steps injection pressure up to



33,000 p.s.i. for 3-lb. aluminum castings, holding it on the injected metal as it chills in the die. By this "slow squeeze" method, metal is injected slowly, letting air and gasses escape ahead of it.

After die cavities are filled, a high injection pressure is applied on the metal as it chills, preventing shrinkage voids and making dense, strong castings that satisfy the X-ray.

The older accumulator, on the other hand, shoots the metal into the die at high velocity but has little energy left for application of pressure at the end of the injection stroke. Hot metal is squirted against the die walls, sealing and closing vents and preventing air and gas from escaping.

No recharging of nitrogen is needed with the new "pre-fill" system. Pressure results from a solid column of oil under sustained pump pressure, being not dependent on expanding gases. The system has been used on fast traverse hydraulic presses, this being its first application on die casting.

The "pre-fill" is a hydraulic cylinder fitted with a large actuating piston, the hollow piston rod of which contains a passageway to a smaller inner fixed piston. Oil under 1000 p.s.i. pressure is introduced through the hollow piston rod, displacing at high velocity the small piston opposing it, which piston also carries with it in its forward movement the piston rod and the attached main or large piston.

As the latter moves fast, oil flows by gravity from a vertical storage tank through a check valve to occupy the space back of the large piston. When die cavities are filled, 2000 p.s.i. oil pressure from a booster pump is applied directly to both pistons.

When the injection piston reverses, the oil is returned to the tank and pump, ready for the next cycle. With magnesium, which chills rapidly, die casters may wish to use both pre-fill and accumulator systems, which is feasible.

In the accompanying photograph the pre-fill system is enclosed in the circle.

## Refrigeration for Welder Tips

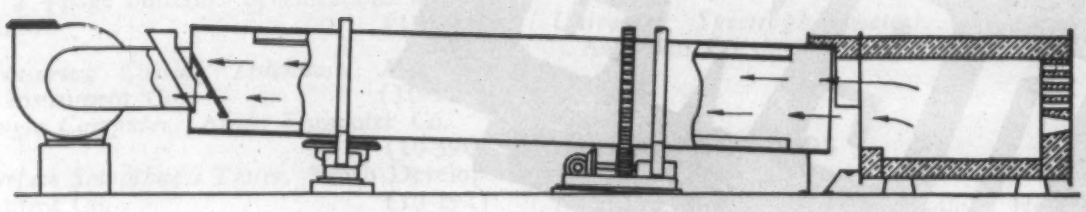
An air-cooled "packaged" 1½-h.p. refrigeration unit, designed for cooling resistance spot welders and for other specialized industrial liquid cooling service, is announced by *Airtemp Div., Chrysler Corp.,* Dayton, Ohio.

It is completely self-contained, equipped with a hermetically sealed radial compressor. It has ample capacity to cool all types of resistance spot welders handling aluminum or ferrous metals.

Called the "Airtemp," the unit has a counter flow liquid cooler mounted in the base. An insulated storage tank is equipped with a ¾-h.p. pump, with capacity of six g.p.m. With the cooling unit in the base, there is no loss of coolant when tips are changed, since liquid drains back to the storage tank.

A regulating valve assures constant pressure. The unit has a high pressure cut out. A remote bulb thermostat, with range of minus 20 F. to plus 20 F. controls the temperature of the coolant.

# "Ruggles-Coles" Dryers Kilns



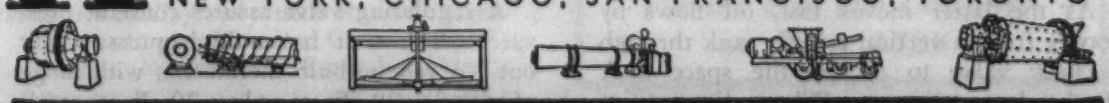
In addition to drying, concentrates in the preparation of base metals, "Ruggles-Coles" Rotary Dryers are drying:

**Coal**
**Coke**
**Charcoal**
**Granulated Slag**
**Moulding Sand**

and burning cutting oil from Aluminum and stainless steel turnings.

If you have a drying problem
Write for information and Bulletin 16-C

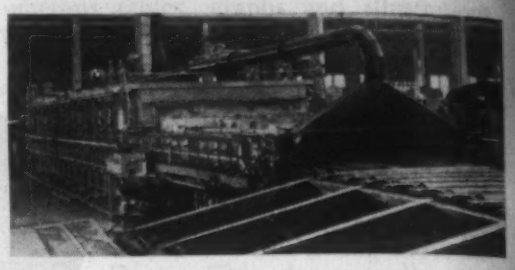
**HARDINGE**
COMPANY, INCORPORATED - YORK, PENNSYLVANIA
NEW YORK, CHICAGO, SAN FRANCISCO, TORONTO



CONICAL MILLS | COUNTER CURRENT CLASSIFIERS | THICKENERS CLARIFIERS | RUGGLES-COLES DRYERS | CONSTANT WEIGHT FEEDERS | TUBE ROD AND BATCH MILLS


## Continuous Annealing Furnace

A versatile continuous annealing furnace in the non-ferrous metal industry that shows flexibility as to variety of products treated, as to range of temperature and atmosphere,



ease of handling and reduction in number of operations, is called the Rockwell continuous roller hearth annealing furnace, and is made by *W. S. Rockwell Co.*, 50 Church St., New York.

It anneals brass slabs at 10,000 to 15,000 lb. per hr., and is well adapted to copper, cupro-nickel and ferrous tubing and rods in straight lengths and coils. The heating chamber has ample clearance for a large range of product height. The work is carried on closely-spaced, highly polished rollers extending the entire width and through the furnace walls.

A sealing box around the neck of the rollers prevents air infiltration into the furnace. A variable speed drive can change heating time. Rollers in the high temperature zone are of chrome-nickel alloy.

Burners are on both sides of the furnace, above and below the hearth level, using gas premixed with the right quantity of air. Combustion and atmosphere are controlled at a single point. Temperature range is 750 to 1800 F.

Free movement of work through the furnace eliminates mechanical distortion, so that straightening is eliminated or minimized. By using variations, the furnace can be used for brazing, normalizing, and hardening on ferrous and non-ferrous products.

● A cutting oil recovery plant for extraction of oil from metal chips is announced by the *Hilliard Corp.*, 400 W. Fourth St., Elmira, N. Y., claiming savings as high as 85% of oil heretofore discarded.

## Electronic Tube Flaw Detector

For production-line detection of longitudinal cracks and seams in non-magnetic metallic tubing, a high frequency electronic flaw detector has been brought out by the *Special Products Div., General Electric Co.*, Schenectady.

It can detect and locate imperfections ½ in. long, 10 mils wide, and one-third the wall thickness in depth, even though they do not appear on either surface. It will well-test tubing for coolers and heat exchangers before installation.

In operation the tubing is fed through a box where coils surround the tubing. Selector switches set the circuit constants for that tubing size, then power is applied to the coils, which induce eddy currents in the tubing. A flaw causes changes in these currents and signals the operator.

# Hard-to-Reach Sections

## Brazed in Seconds with MEGATHERM Heat

... a simple, speedy operation with new High Frequency Technique

*Federal Industrial Power Tubes, built with the ultimate of care and workmanship, give power and performance to Megatherm and other industrial heating equipment.*

***PROBLEM:*** **How to braze an inner cup to the outer shell of an aircraft part . . . in *seconds*?**

***ANSWER:*** **Megatherm High Frequency Heat — with definite control of heat location by means of a simple director coil!**

**By the use of similar coil units, precision localized heat applications can be made on a wide variety of difficult jobs.**

**Megatherm accomplishes this and other brazing or silver soldering operations on small complicated parts, with precision results — at high speed, under ordinary atmospheric conditions and without warpage, burning or surface contamination.**

**Low power requirements and overall economy make Megatherm High Frequency brazing and soldering an important production tool.**

**For technical data on Megatherm's new and fundamental advantages for brazing, soldering, annealing and surface hardening write Department N.**

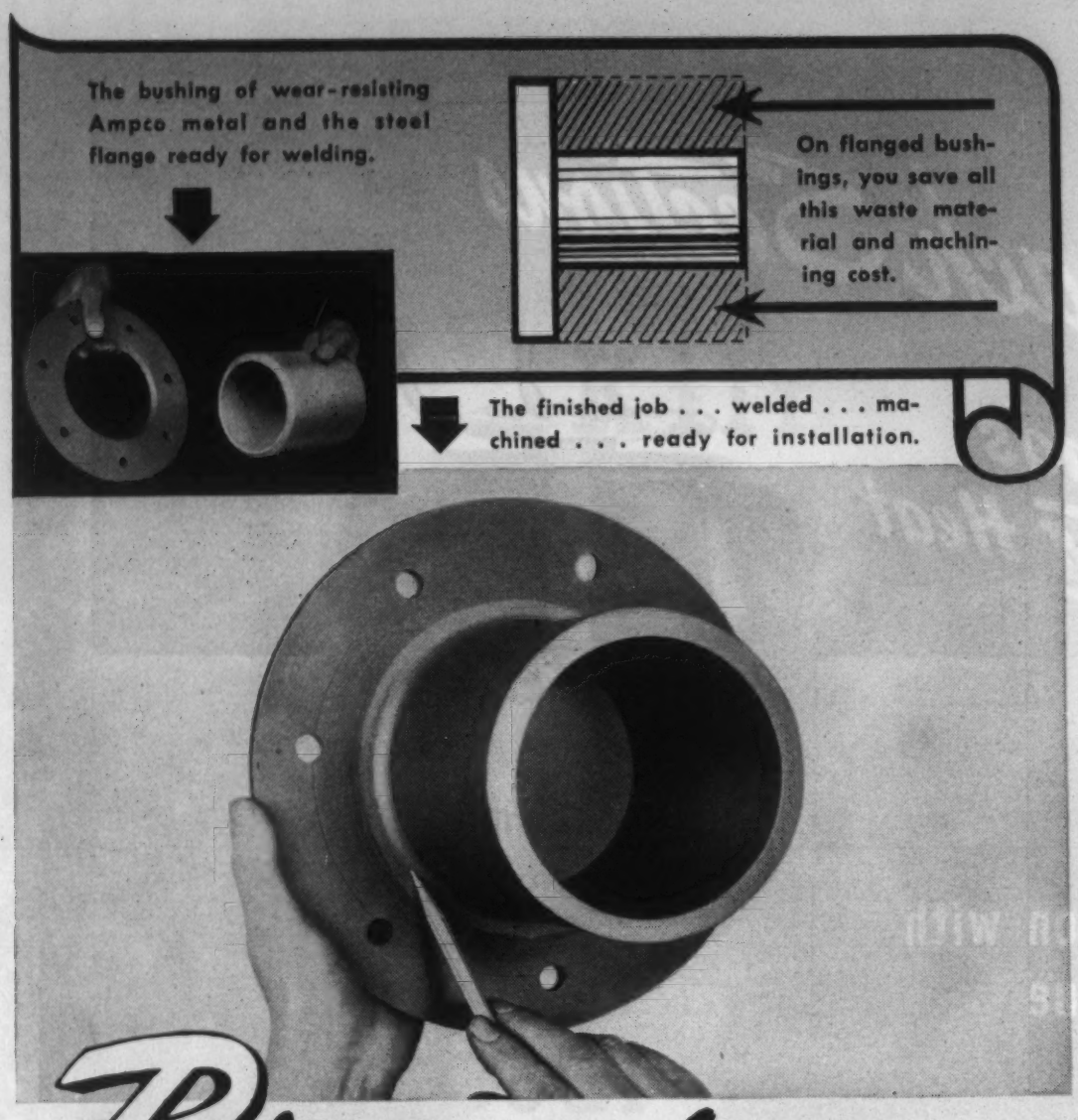
**-MEGATHERM-**

## Federal Telephone and Radio Corporation

INDUSTRIAL ELECTRONICS DIVISION

AN IT&T ASSOCIATE

Newark 1, N. J.




# Big saving
## in fabricating frictional parts for machinery . . . with
# Ampco-Trode
## WELDING ELECTRODES

Welding — the fabricating method which has made such tremendous strides in war production — offers you an economical means of fabricating dissimilar metals, building up bearing surfaces on cheaper base metals, etc.

Illustrated above is an example of the tremendous savings that can be made by welding a bushing of Ampco Metal to a steel flange. Ampco-Trode coated aluminum bronze welding electrodes give you weld metal that is comparable in strength, ductility, and bearing qualities with the various grades of Ampco Metal — the superior aluminum bronze alloy. Any grade of Ampco-Trode, selected for your required physical properties, can be welded to practically all combinations of metals and their alloys.

Perhaps you can apply this modern fabricating method to your product. Investigate — a letter or postcard will place a competent field engineer at your service immediately without charge.

*Write today for Ampco-Trode bulletin 61 and further information.*

**Ampco Metal, Inc.**
**Department MA-6** **Milwaukee 4, Wis.**

**Ampco Metallurgical Specialties**

*Ampco Metal — a grade to meet your requirements. . . . Ampcoloy (general industrial bronzes) . . . Special Copper-base-Alloys.*

Reg. U.S. Pat. Off.
AMPCO
**Metal**
**The Metal without an Equal**

*Sand Castings . . . Centrifugal Castings . . . Extruded and other Wrought Products . . . Precision-machined Parts . . . Ampco Non-Sparking Safety Tools.*

W-3


## Rocker Arm Welder for Structural Aluminum

A rocker arm welder capable of handling in continuous production the spot welding for aircraft and other types of equipment of structural aluminum sections up to ⅛ in. Alclad has been announced by *Progressive Welder Co.*, 3050 E. Outer Drive, Detroit 12.

The new Model "C" welder is a larger companion model to the Model "B" standard rocker arm welder recently announced by the company for welding Alclad up to 0.081-St.

Designed for a conservative production rate of 1000 to 2000 spots per hr. when welding heavy sections, the model "C" is notable for the extreme rigidity of its construction. While the welder is rated at a maximum point pressure of 6500 lb. (at 90 lb. factory air line) deflections even under such conditions are held to a minimum.

In the rocker arm design, the practice so successful in the Model B of throwing all deflections into the vertical plane has been followed also on the Model "C". As a result, these deflections can be used to improve the weld by providing a "spring follow-up" during the weld.

The welder will handle fairly large size work, throat depth being adjustable from 36 to 42 in., and throat opening from 7½ to 17½ in. In addition to the normal 1 in. working stroke of the rocker arm, the latter is also provided with a retracting stroke that provides a 4½ in. clearance between points to permit insertion of flanged work. This retracting stroke is controlled through one of the dual shrouded foot switches provided with the machine.

● A new coated aluminum-bronze electrode, Airco No. 100, has been brought out by the *Air Reduction Sales Co.*, 60 E. 42nd St., New York 17. It is a shielded arc electrode, and can be used as filler rod in carbon arc welding. It is superior to standard manganese bronze as to corrosion resistance, and equal in strength, hardness and ductility. Standard applications are on most bronzes, malleable and cast iron or steel. It can weld dissimilar metals such as cast iron to brass, steel to malleable iron, etc.

## Electronic-Controlled Tracer

A contour of a model, such as of a propeller, die or cam, can be duplicated within two or three thousandths of an in. when feed speed of the machine tool is 20 to 30 in. per min. with a new tracer mechanism, developed by *Westinghouse*, for use with its Silverstat regulator.

In operation a probe, mounted with the Silverstat, follows the contour of an accurate model, either actual size or to scale. Through an electronic amplifier the cutting tool is moved correspondingly with respect to work.

A TESTING DEPARTMENT COSTS LESS THAN A GUESSING DEPARTMENT

# NEW SF-01U

**100 Pound Universal Fatigue Testing Machine for PLASTICS PLYWOOD METALLIC MATERIALS**

A constant stress fatigue testing machine for
1. Tension-Compression 2. Torsion 3. Flexure

Alternating Force Capacity 100 lb
Adjustable in units of 0.2 lb

Maximum capacity in Bending (no preload) 200 in. lb
Maximum capacity in torsion (no preload) 1125 in. lb
Speed of Alternating Force (synchronous) 1800 r.p.m.

Ample space for testing bulky assemblies, easily adjustable for various specimen sizes.

*Write for Bulletin 206*

**BALDWIN PRODUCTS**

Hydraulic presses, Testing equipment, Steel forgings and castings, Diesel-electric locomotives, Diesel engines, Metal plate-fabrication, Rolled steel rings, Bronze castings, Heavy machine work, Crane wheels, Bending rolls, Plate planers, Babbitt metal, Alloy iron castings, Briquetting presses.

The Baldwin Locomotive Works, Baldwin Southwark Division, Philadelphia, Penna. U.S.A. District offices: Philadelphia, New York, Chicago, Washington, Boston, Cleveland, St. Louis, San Francisco, Houston.

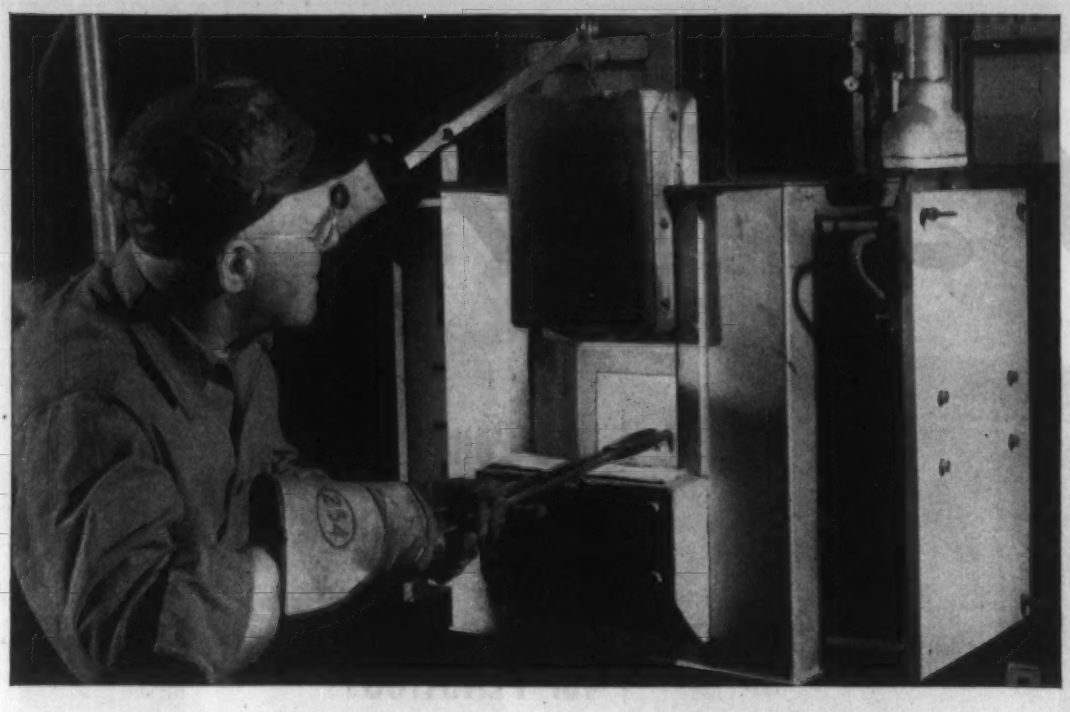
BLW THE BALDWIN GROUP

**BALDWIN**

**SOUTHWARK**

***TESTING EQUIPMENT***

# *"Eminently Satisfactory Results"*



**Size 2 Model Y Sentry Furnace in Operation**

**Tools—correctly hardened—true to size—scale free and without decarburization or soft skin.**

**You don't need to put up with less in heat-treating high speed steel tools. One plant reports:—**

***"Since installation, we have heat treated approximately 100,000 pieces in our Sentry high speed furnace without a single failure."***

**If you are not getting results like this, investigate the Sentry Furnace and its inherently neutral atmosphere assured by Sentry Diamond Blocks.**

*Ask for Bulletin 1012-6C*

**The Sentry Company**
FOXBORO, MASS., U. S. A.


## Current Interruptors for Welders

A new current interruptor for inductive d.c. circuits in resistance welding, called the Dynatrol, is announced by *Sciaky Bros.*, 4915 W. 67th St., Chicago 38. It is designed to replace magnetic contactors formerly used on resistance welders of the electro-magnetic stored energy type, which, because of continuous arcing, required periodical maintenance and replacement, and suffered power loss.

The Dynatrol interrupts the charging current without arc, reducing maintenance, increasing efficiency, and resulting in 20% greater operating speed. It is a high-speed, single pole interruptor, the contact points of which are shunted by a bank of capicitors.

Movable contacts open with very high acceleration, so that at any instant they have separated sufficiently to prevent a discharge, while the primary current is directed to the capacitors.

It is available on all Sciaky Stored Energy Welders up to and including 50 kw.

● A new master control switch for heavy duty service, Type SB-9, for use where repetitive operations of electrically-operated devices run into many thousands per week is announced by *General Electric Co.* It is especially serviceable in steel mills for opening and closing control circuits from the control desk. It can be mounted on panels from 1/8 to 2 in. thick, is rated at 600 volts, 20 amp. continuous or 250 amp. for 3 sec.

## Handy Eyeshield and Lens

A combination eyeshield and lens permits the use of both eyes, leaves the hands free, and is used in high precision work or inspection jobs. Announced by *Eastman Kodak Co.*, 10 E. 40th St., New York, the shield prevents stray light or side glare from disturbing vision.

The body is made of black Tenite plastic, which is shatterproof, while surfaces are lustrous and dirt-resistant. A lockscrew adjusts for fit.

# . . . that calls for Forgings by PHOENIX

● Few things must take a worse beating than the moving track of an Army tank . . . and no one knows this better than Burgess-Norton Manufacturing Company, manufacturers of track link body assemblies for Army tanks. That's why these end connectors, which are a part of the track, are drop-forged.

Since July, 1942, Phoenix has supplied Burgess-Norton with hundreds of thousands of these connectors, both large and small. They are broached to the end and side diameters for seamless or welded tubing and ground on the ends to fit with .0015 to .002 tolerance. Half rings of copper are placed at joints of tubing and forgings, and run through hydrogen copper brazing furnaces, brazing them together with a bond stronger than either part. Result . . . a track link that is able to withstand the terrific shocks and strains of modern tank warfare.

This is but one of the many applications of Forgings by Phoenix in the manufacture of the tools of war . . . applications which demand the utmost in strength and stamina, freedom from concealed defects, welding adaptability, and economy in fabrication. And these same qualities will again be available to you after V-day.

A Phoenix engineer will gladly work with you . . . today . . . on your postwar plans . . . and there's no obligation.

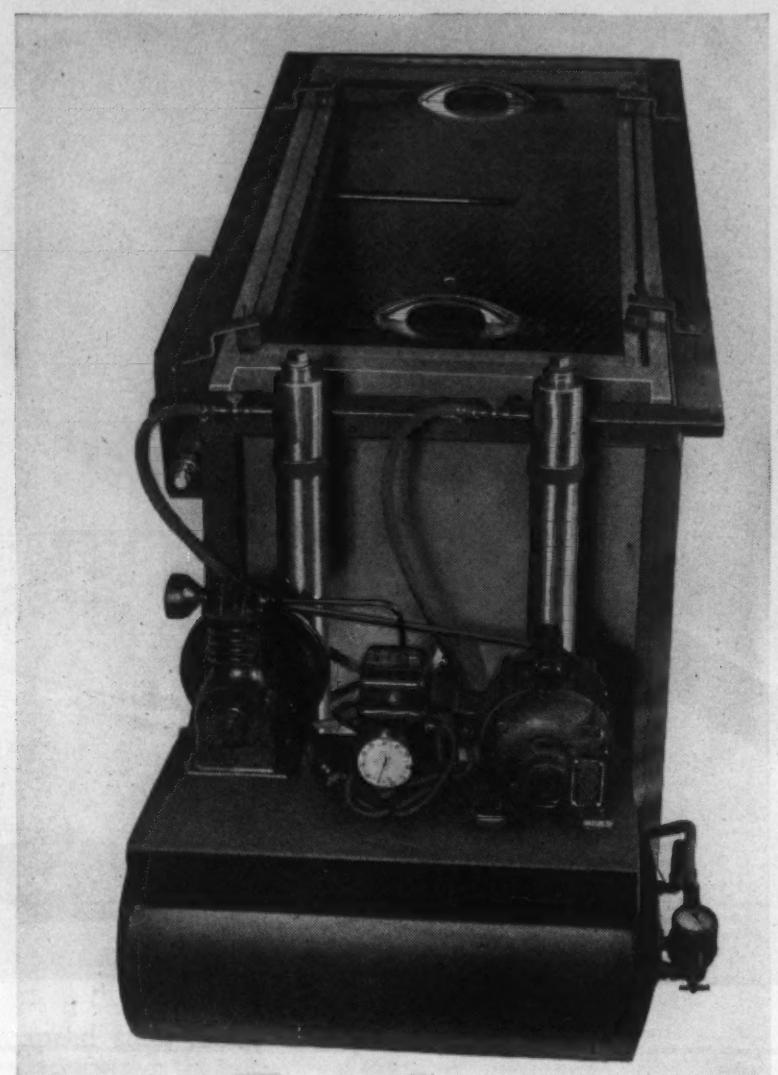
*Forging Division of*

**PHOENIX MANUFACTURING COMPANY**

**CATASAUQUA PENNSYLVANIA**

*Forgings by* **PHOENIX**

# The Munning *Improved* Salt Spray Testing Apparatus



*This improved Spray Unit is recommended for producing Accelerated Corrosion Tests to simulate service behavior.*

The serviceable life of electrodeposited articles can be determined by testing for corrosion resistance of base metal and permeability of the plated coating.

This method is conceded to be one of the most practical and dependable for inspecting specimens and ascertaining results as they would appear in outdoor exposure.

The Munning Improved Salt Spray Test consists of a Thermostatically controlled Salt Spray Chamber.

Two Air Washing Towers—one for oil, one for dust.

Air Compressor.

Storage Tank.

The Chamber is an inclined Alberene stone box, approximately 39½" long, 26½" wide, 25" deep, with water tight plate glass cover. Reinforced welded steel frame supports tank in position.

All internal metallic parts are of Monel construction; consist of Immersion Heater, Spray Nozzle and Thermometer Control Bulb.

These Units are designed for flexibility. They meet varied specifications, and prove easy and economical to operate.

We will be pleased to furnish further details on our Improved Salt Spray Test Equipment. Write or 'Phone.

## Munning & Munning, Inc.

**Engineers • Designers • Manufacturers**

**Main Office and Factory, 202-208 Emmett St., Newark 5, N. J.**

NEW YORK -:- PHILADELPHIA -:- WOONSOCKET, R. I.


## Automatic Dimensions Checker

A device that makes it possible to check the dimensions of all production parts individually at no greater cost than spot-check inspection, has recently been placed on the market by *Interlakes Engineering Co.*, 502 Transportation Bldg., Detroit 26.

This machine, called the "Check-Matic," provides automatic inspection of parts up to 1½ in. in diam. and 2 in. in height, checking "go" and "no-go" on such dimensions as outside and inside diameters, depth of counterbore, wall thickness and depth of holes, all to limits of 0.001 in.

Parts to be inspected are simply placed in the holes of the machine's revolving dial, which carries them to the various gages for the series of inspection operations. If any part, as it progresses from one gage to another, does not meet any particular inspection test, it is automatically rejected through a tube that deposits it in a receptacle placed at the tube's outlet. As each gage has its own individual rejection tube, the rejected parts are segregated according to the particular inspection which they fail to pass.

The standard model has an 18-hole dial, and is designed to check as many as 13 individual dimensions. The gaging elements and dial bushings can be quickly changed for the inspection of parts of different shapes and dimensions.

By eliminating the human element, the "Check-Matic" makes for more accurate inspection than has been possible heretofore, and reduces inspection time to a fraction of that formerly required.

● A new electrolytic method of marking steel, yielding 1200 to 1500 impressions per hr., is announced by the *Acme Metal Marking Equipment Co.*, 2222 W. Fort St., Detroit 16. Called "Met-L-Etch," it consists of a compact unit 2 in. by 6 in. by 9 in., with a 110-v. a.c. transformer. A drop of conductive solution, good for 500 impressions, is applied to a silver pad on which rests a celluloid stencil engraved with the mark to be etched. The work is placed on the stencil in contact with adjustable guide posts. Slight pressure turns on the current, one second being required for operation.

## Aircraft Putty with Post-War Uses

Now that camouflage paint has been removed from fighting airplanes, further methods are being devised to reduce skin friction. One new product is a flexible high-adhesion aircraft putty for filling dents and cracks between riveted aluminum sheets forming aircraft wings, developed at the Parlin, N. J., laboratories of *E. I. du Pont de Nemours & Co., Inc.*, Wilmington 98.

The new du Pont No. 228-711 aircraft putty has a buttery consistency and stays in place. It does not flow nor sag on vertical surfaces. It weighs one-fifth less than conventional putties. It is expected to have post-war uses such as finishing rough metal castings and railroad coaches.

# SLIPPERY FLOORS ARE DANGEROUS!

## *Eliminate* ACCIDENTS!

## Keep your floors safe and clean with *Park* SAF-T-GRANS

Don't let slippery floors rob you of vital help. Park's SAF-T-GRANS actually removes oil and grease from wood, steel or concrete floors by its physical action of absorption.

This new idea in cleaning oil soaked and greasy floors reduces cleaning time to a minimum, thus saving manpower for more productive jobs. SAF-T-GRANS reduce fire hazard because they do not burn readily, even when saturated with oil. They are safe to use too for they do not harm the hands or clothes.

SAF-T-GRANS do such an efficient job of cleaning it will pay you to try a bag of this cleaner to prove to yourself SAF-T-GRANS are superior to ordinary types of cleaners. Order a bag today!

### SAF-T-GRANS ARE EASY TO USE

By merely spreading a layer of SAF-T-GRANS over the floor and sweeping with a push-broom all traces of oil and grease are removed. After the original accumulations of dirt and oil have been removed smaller amounts of SAF-T-GRANS are required.

*Park*
PARK CHEMICAL CO.
DETROIT . . . . . MICHIGAN

**WRITE TODAY FOR FULL INFORMATION**

**Prompt deliveries on orders for one bag or a carload.**

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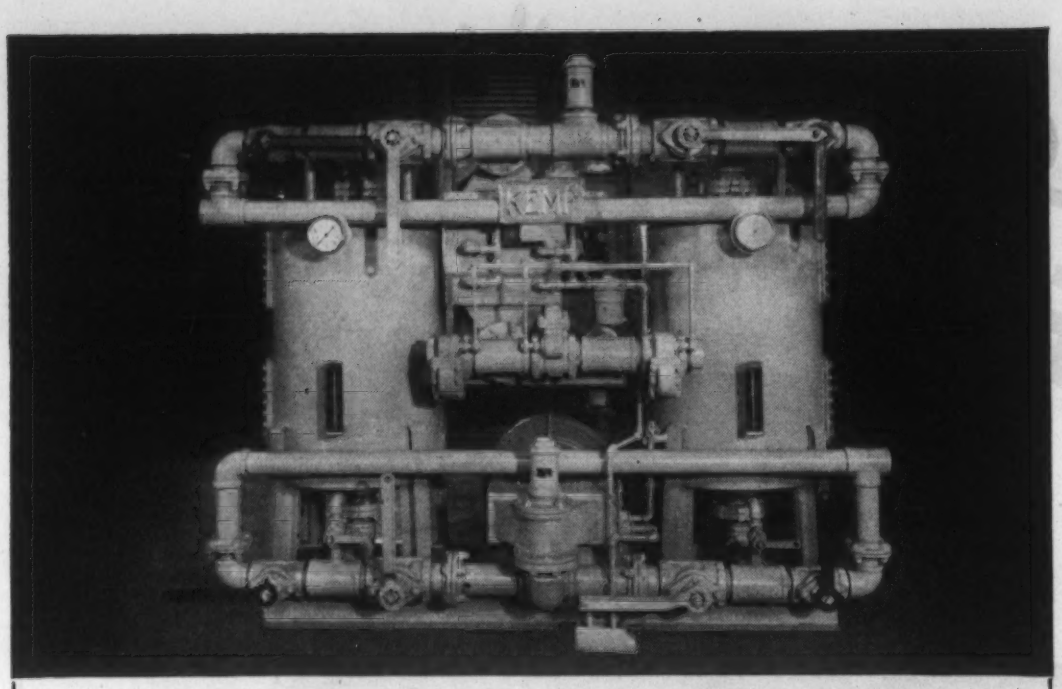


**Send us your inquiries—**

*—for adsorptive dryers*

*—for inert and atmosphere gas generators*

Our ability to furnish equipment to supply your needs and meet specifications is assured by Kemp's extensive experience, equipment, and unsurpassed engineering and fabricating personnel.

Unusual and highly efficient methods of gas application by us to industrial and process heating operations are productive of real benefits.

For technical bulletins, descriptive leaflets and general information, address The C. M. Kemp Mfg. Co., 405 East Oliver Street, Baltimore-2, Maryland.

**KEMP of BALTIMORE**

## New Refractory Coating

A new refractory coating, applicable to foundry and heat-treating fixtures, to prolong their life under intense heat, called "Neo-Kote-P 101," has been developed by the *Neo Mold Co.*, Cleveland.

Typical applications are magnesium and aluminum melting pots, core baking boxes, loading racks for high-temperature furnaces, and heat-treating fixtures of various types. It greatly increases the number of heats to which equipment can be subjected before breakdown from oxidation and flaking.

Thus, melting pots or crucibles for magnesium, aluminum and bronze, which formerly broke down after 25 to 30 heats, when treated with Neo-Kote lasted 50 to 60 heats, or even 75 to 90 heats, and in rare cases, 100 heats. Accessories to be treated need only to be blast-cleaned in preparation. When coating shows signs of deteriorating, it can be renewed if the steel has not started to scale.

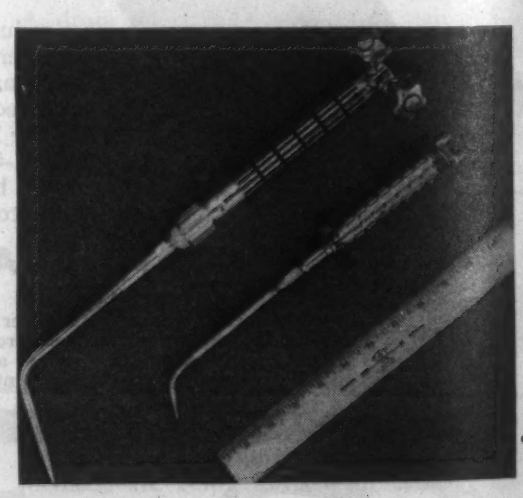
The coating is done only in Neo Mold's Cleveland plant, operated at 24 hr. daily.

## Lightweight Welding Torch

A compact lightweight welding torch, designed for aircraft tubing, aluminum, various alloys and all other sheet metal up to ¼ in. in thickness, is announced by the *National Cylinder Gas Co.*, 205 W. Wacker Drive, Chicago 6, as a part of its new Torchweld line of welding and cutting equipment.

Weighing only 8 4/5 oz., complete with a commonly used size of tip, this torch, called the Aircrafter, has an overall length of less than 12 in. The handle is ⅞ in. in diam. and 4⅛ in. long.

Easy to manipulate, the torch is designed for delicate, precision work in "hard-to-get-at" light metal work, and is expected to be



exceptionally useful to women welders. Two styles of copper tips, both producing soft, medium-pointed flames that give deep penetration without blowing hot metal, are offered, and both can be swiveled to any position.

A tip head for screw-in style tips is made of special heat resistant cupro-nickel. Mixers incorporate the patented "non-flash" principle.

(*Continued on page* 1550)

# THE FACTS ABOUT SMALL METAL TUBING UP TO 5/8" OD

Superior facilities are devoted exclusively to the production of small metal tubing. Long before the war we set our maximum size at 5/8" OD because experience has shown that only by so doing could we maintain high quality in the smaller diameters. As a result, we have a mill, operating at top speed, equipped to produce in a routine manner what formerly was known as "specialty" tubing. So, if you need cold drawn tubing in any metal, and the OD does not exceed 5/8"— then the inherent benefits of our specialization are yours for the using.

# SUPERIOR

THE BIG NAME IN SMALL TUBING

SUPERIOR TUBE COMPANY, NORRISTOWN, PENNSYLVANIA

FOR EVERY SMALL TUBING APPLICATION FROM 5/8" OD DOWN

SUPERIOR Seamless in various analyses. WELDRAWN Welded and drawn Stainless, "Monel" and "Inconel"

SEAMLESS and Patented LOCKSEAM Cathode Sleeves

# OXYGEN FREE HIGH CONDUCTIVITY COPPER

OFHC
REG. U.S. PAT. OFF.

- Hitherto the distribution of O.F.H.C. Copper has been restricted to certain special end uses such as electronics.
- O.F.H.C. Copper and a few special dilute alloys thereof are now available for most uses.

THE AMERICAN METAL COMPANY, LTD.
61 Broadway, New York, N. Y.


## Redesigned Bending Rolls

A completely redesigned line of bending rolls capable of rolling angles, tees, flats, rounds, squares, pipe, beams, channels and special shapes is introduced by *Thomas Machine Mfg. Co.*, Pittsburgh. Arcs, spirals or circles can be formed on the machines, built in four sizes.

They are all steel construction, with cast steel bearing housings welded into place. Bearings are bronze bushed and lubricated with high pressure fittings.

Rolls can bend angles 2 by 2, 3 by 3 and 4 by 4 in. in the vertical type machine, and up to 6 by 6 in. in the horizontal type. Weights for the four sizes range from 3,500 to 35,000 lb.

One interesting feature is an adjustable auxiliary roller that counteracts twisting and keeps the leg of the angle square when rolled, leg in. When rolled leg out, this roller serves as a gage to indicate when the proper diameter is rolled, and can be used for enlarging circles that have been rolled too small.

• A unique lift front lens holder highlights a new line of welding helmets just introduced by the *Chicago Eye Shield Co.*, 2300 Warren Blvd., Chicago 12. It may be used in the semi-open position, affording the operator a clean view of his work while protecting him from harmful flashes. The holder may be opened a full 90°. Intermeshing beaded surfaces assure a positive "blacking-out" of light rays.

*How Silicate Cleaners treat solid dirt*

The most difficult material to remove in metal cleaning processes is solid dirt, such as carbon and particles of polishing compounds. During operation this dirt is dispersed in the cleaning solution. When the cleaner contains soluble silica in proper proportions, the suspended dirt is prevented from redepositing on the surface of the work.

Deflocculating the removed dirt is one of the important functions of silicates in metal cleaning. Other properties are quick wetting, high emulsifying power, free rinsing.

Ask for a copy of "Alkalis for Metal Cleaning" which reviews sodium metasilicate and sodium sesquisilicate metal cleaners.

**METSO GRANULAR** Sodium Metasilicate U. S. Pat. 1898707
**METSO 99** Sodium Sesquisilicate U. S. Pat. 1948730, 2145749

# metso Cleaners

**PHILADELPHIA QUARTZ CO.** • Dept. C. 125 S. Third St., Phila. 6


## Electrolytic Remover of Broken Drills

An electrolytic process that removes broken drills and taps from castings and machined parts in non-ferrous metals and stainless steel, called the Mechemel method, is announced by *Mechemel Engineering & Sales Co.*, 4313 Lincoln Ave., Chicago 18. The process disintegrates and dissolves the embedded fragment of tap.

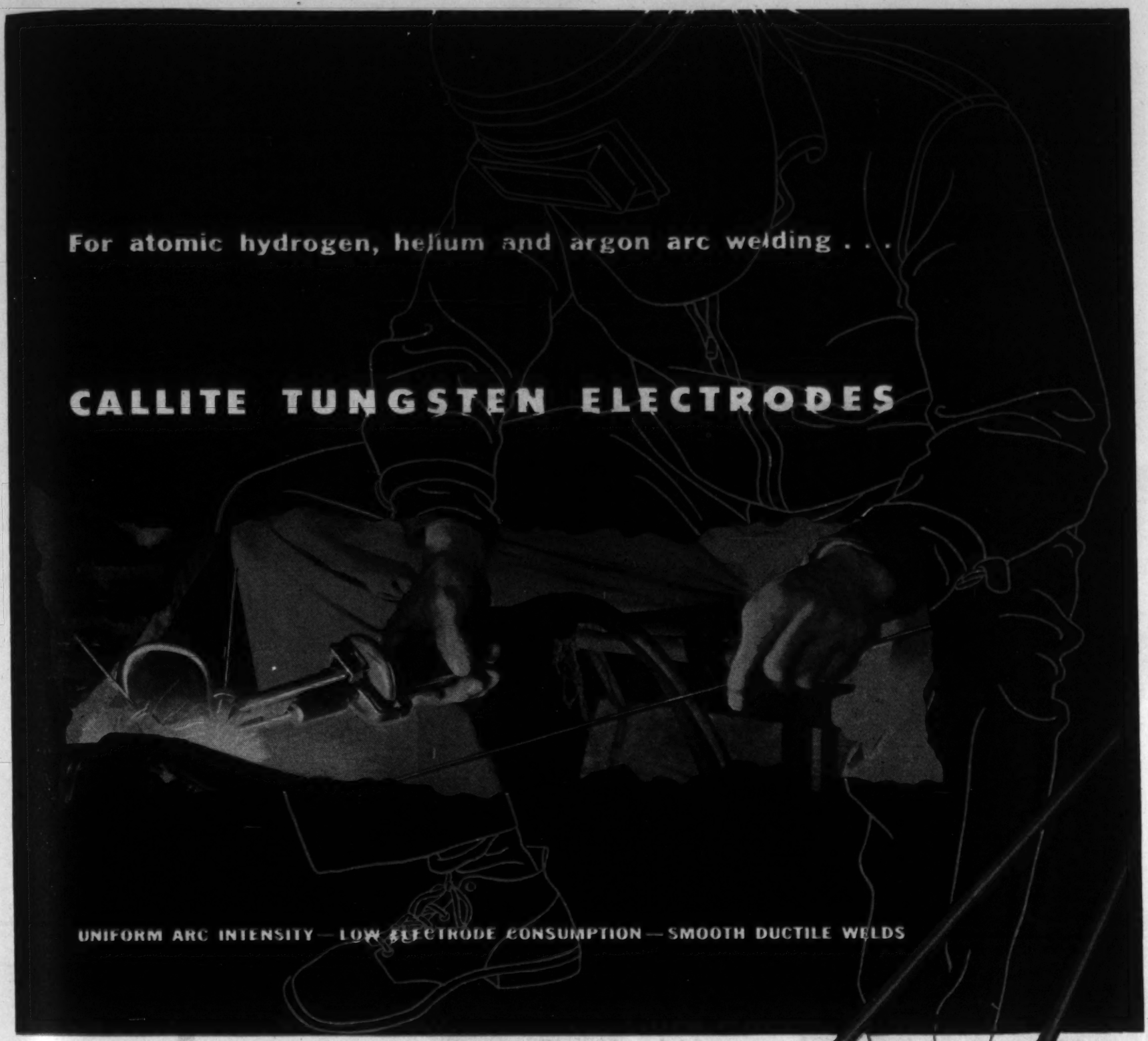
Blocking agents in the solutions prevent attack on the main body of the metal, hence there is no change in hole or thread dimensions when the fragment is removed. An electronic unit operating on 110-v. a.c. controls the process.

An unskilled workman can remove up to three dozen taps at one time without constant attendance on the operation. A special formula is tailored to every non-ferrous metal and alloy in common use.

● *Pennsylvania Salt Mfg. Co.*, 1000 Widener Bldg., Philadelphia 7, announces four new products: Pennsalt E.C.10, a solvent emulsion cleaner; fluoboric acid, FA42, for use in electroplating baths, etc.; lead fluoborate solutions, LF42 and LF50, for use in lead electroplating; and emulsion cleaner, EC2 for industrial grease cleaning applications.

For atomic hydrogen, helium and argon arc welding . . .

# CALLITE TUNGSTEN ELECTRODES




The Atomic Hydrogen process is proving valuable in tool-making or repairing and for the quick altering of dies and molds to accommodate design changes. Such welding depends on a sustained arc of uniform intensity and the accurate control of heat, concentrated at the point of work. Of 99% pure tungsten, Callite Electrodes retain their stiffness, keep the arc properly spaced and are consumed slowly. They produce strong, dense, smooth deposits, readily machineable.

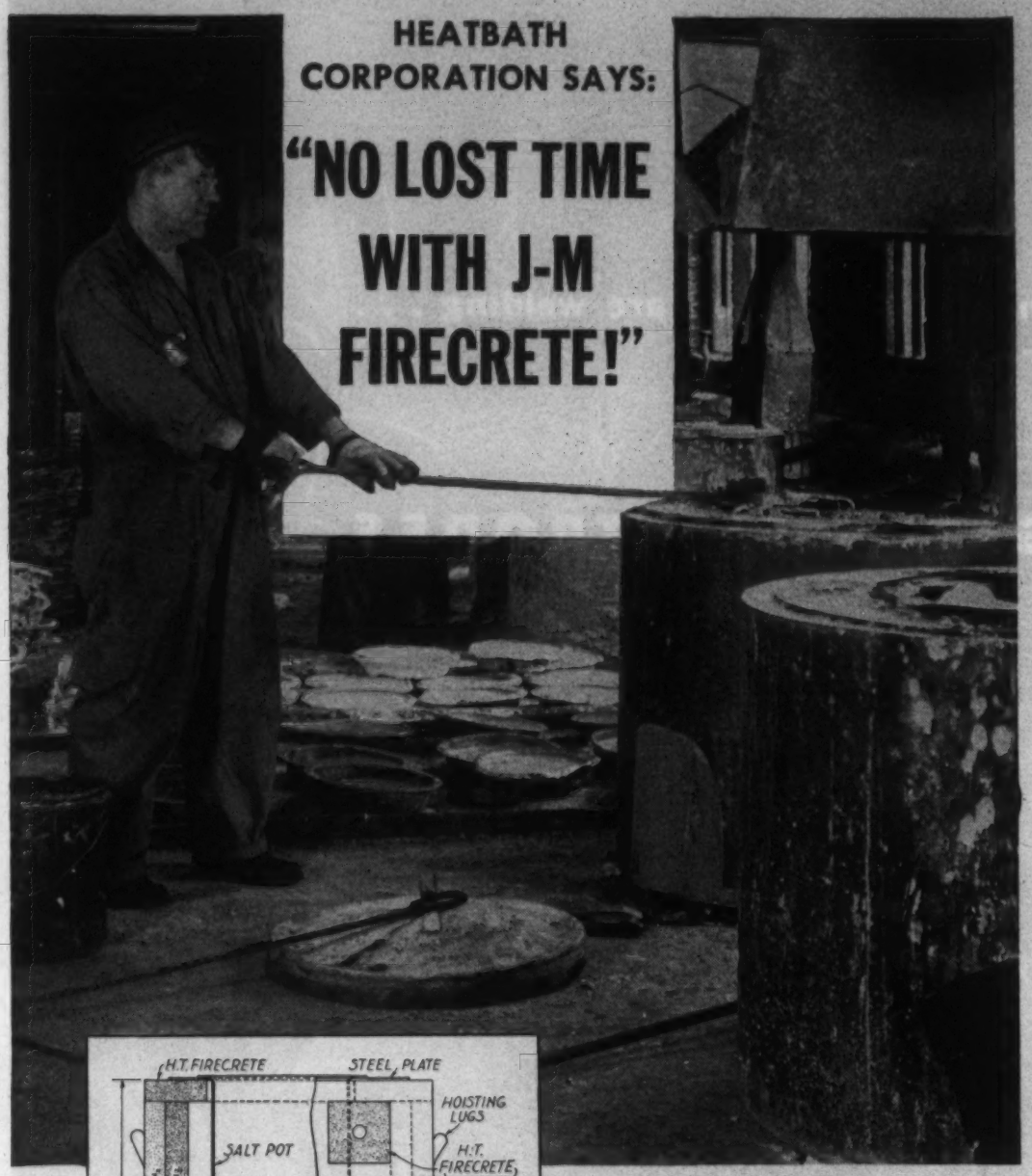
In applying tungsten carbide hard facing material to their Soft Formation Core Bit Cutter Head, the Hughes Tool Company uses C-T Tungsten Electrodes. This and other interesting applications, including aircraft welding, are described in our Bulletin No. 154. Look into the possibilities of Atomic Hydrogen welding for your business. Write us for more information about it. Callite Tungsten Corporation, 546 Thirty-ninth Street, Union City, N. J. Branch Offices: Chicago and Cleveland.

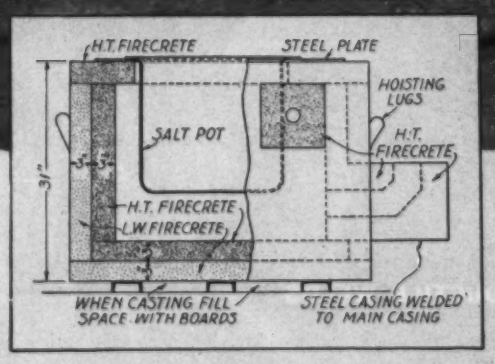
*Callite*

Standard or special-polished, clean and black. Seven standard diameters, 12-inch lengths; other random lengths and unusual diameters on special order. Send for Bulletin No. 154.

**TUNGSTEN ELECTRODES**

PIONEERS IN TUNGSTEN METALLURGY OVER 25 YEARS




*A battery of Heatbath furnaces made of J-M Firecrete.*

*This cross-section shows how 2 types of Firecrete were used by Heatbath engineers.*

BY CASTING their own furnaces of Johns-Manville Firecrete, the Heatbath Corporation of Indian Orchard, Massachusetts, eliminated furnace shutdowns that were caused by waiting for delivery of special refractory shapes.

This costly shutdown problem was solved for this company because Firecrete can be cast as simply as ordinary concrete and then placed in service after 24 hours of air curing.

Three grades of Johns-Manville Firecrete are available—Standard Firecrete, 2400° F.; H.T. Firecrete, 2800° F.; L.W. Firecrete, 2200° F.

For complete details write for brochure RC-13A. Johns-Manville, 22 East 40th Street, New York 16, N. Y.

JM

**JOHNS-MANVILLE Firecrete**

***The Standard in Castables***


## Air-Operated Precision Gage

A new air-operated precision gage has been designed for the measurement of slots and thicknesses by *Metrical Laboratories, Inc.*, 417 Detroit St., Ann Arbor, Mich. The gages use the flow of air as a measuring medium, and operate with the single position "Metricator" that is used to indicate size variations.

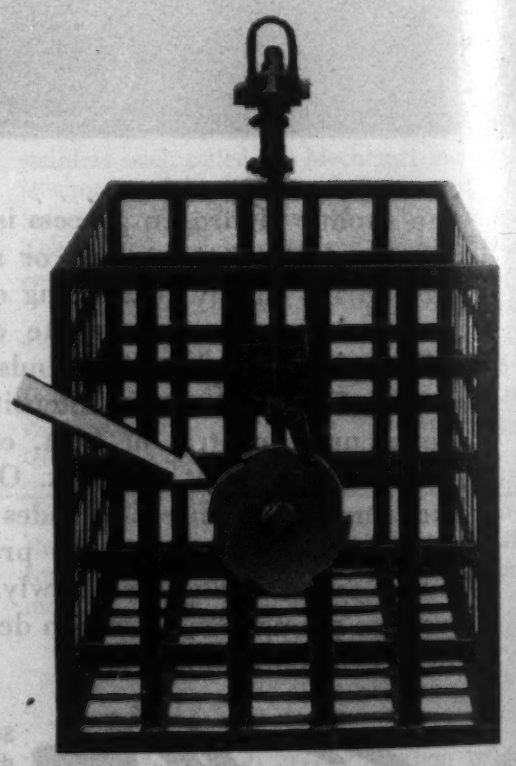
A feature is that the gages are not influenced by wear and measurements are the same regardless of the skill of the operator. The parts are fed over a rail past the measuring orifices.

The instrument is graduated in 0.00005 in., and can be read accurately to 0.000025 in. because of high amplification representing 0.001 in. as a space of 4 in. on the scale. The lack of mechanical devices makes maintenance easy.

● A new method of spinning asbestos fibers into fine yarns has been developed by the *United States Rubber Co.*, Rockefeller Center, New York. Fabrics made from these yarns, known as Asbeston, are extremely lightweight, fire-fighting suits weighing only one-half normal. Such suits are used at airports, on aircraft carriers, etc. Many new and unusual applications for post-war are predicted.

## Ratchet on Pickling Basket

To facilitate drainage of pickling baskets, a ratchet that permits the basket to be tipped in six different positions has been developed by *Youngstown Welding & Engineering Co.*, Youngstown, Ohio.

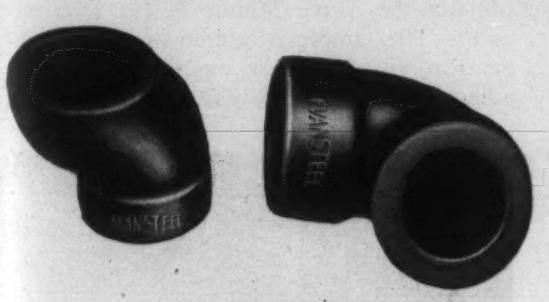


In pickling pots, pans, vessels and many types of metal parts, it is necessary to drain the pickling acids from within the containers easily and quickly.

Though the lattice work naturally provides good drainage, a tipped basket augments removal of pickling solution.

# EVANSTEEL

## For Extra Strength and Hard Wear



AIRPLANE PARTS

HEAVY DUTY PIPE FLANGE

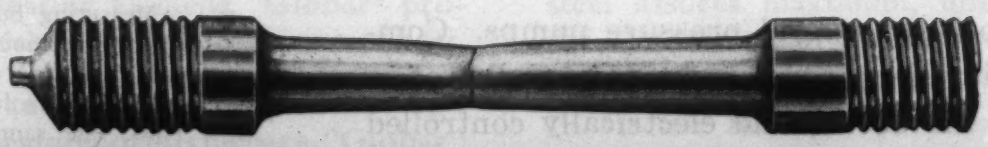
WHEN important *cast steel parts* are required for resisting heavy stresses, severe abrasion, shock loading and vibration . . . you can specify EVANSTEEL with assurance it will stand up under the toughest assignments.

EVANSTEEL has earned many citations for service "beyond the call of duty" not only in war equipment parts, such as illustrated, but also in essential industrial applications as for pulverizer hammers, wire rope sockets, pug mill knives, screen plates, and other hard-used parts.

The typical test bar shown below exemplifies the super-strength, developed in EVANSTEEL, the modern alloy steel for high-strength applications.

HALF-TRAC TREAD GUIDE

GUN SIGHTING PARTS



TENSILE STRENGTH 249,300 LBS. P.S.I.
ELONGATION 18.8 %

EVANSTEEL
for strength

PYRASTEEL
for high temperatures

## CHICAGO STEEL FOUNDRY COMPANY

Makers of Alloy Steel for over Thirty Years

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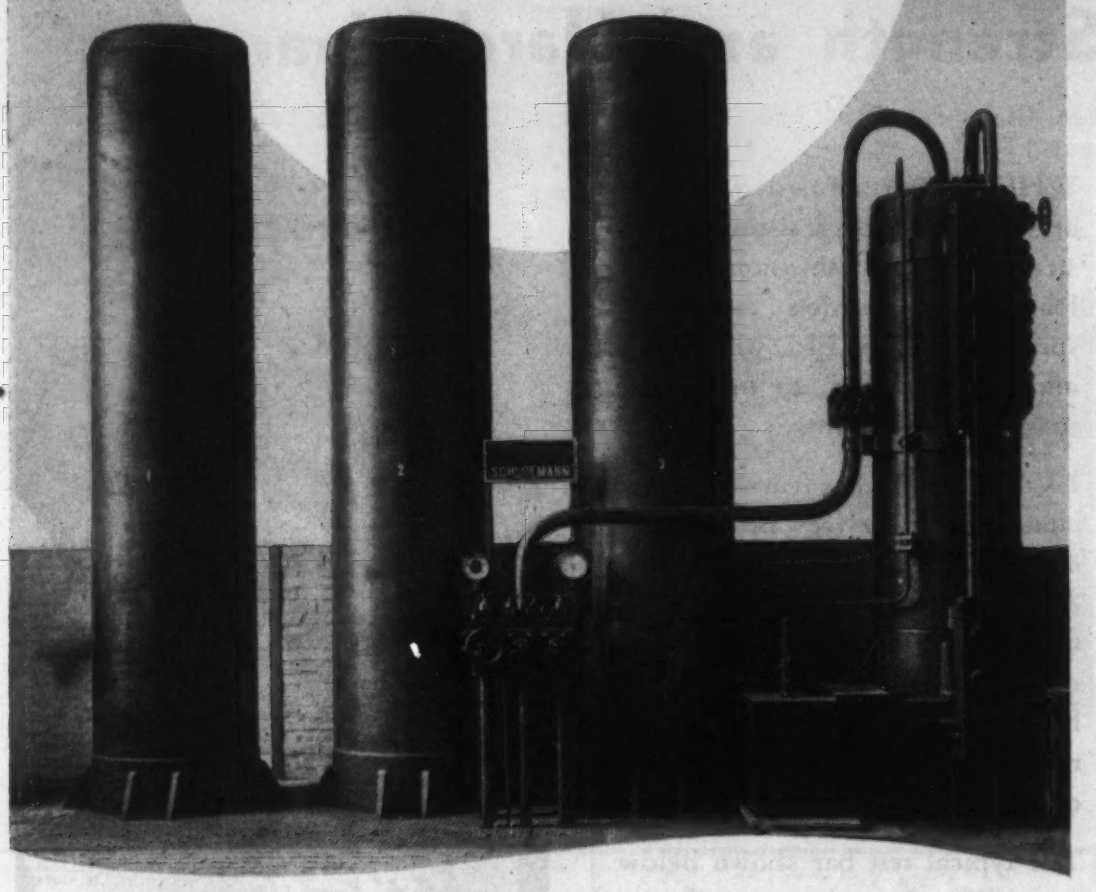
# SCHLOEMANN

## Air-Hydraulic Accumulators

### PROVIDE PRESSURES

*from*

### 1000 to 5000 POUNDS p.s.i.



★ With a range of 50 to 800 gallons useful water capacity, Schloemann Air-Hydraulic Accumulators provide pressures from 1000 to 5000 pounds per square inch for controlled feeding of hydraulic presses. They may be fed by one or several pressure pumps. Completely automatic, they consist fundamentally of a water bottle, an air bottle, and electrically controlled regulating apparatus. Schloemann accumulators require but little floor space and a light foundation. Control elements are located at accessible places where they are well protected. Signal devices include a horn and siren which operate at overpressure and low water level. Schloemann Air-Hydraulic Accumulators are outstanding for reliable pressure control.

**SCHLOEMANN**

ENGINEERING CORPORATION

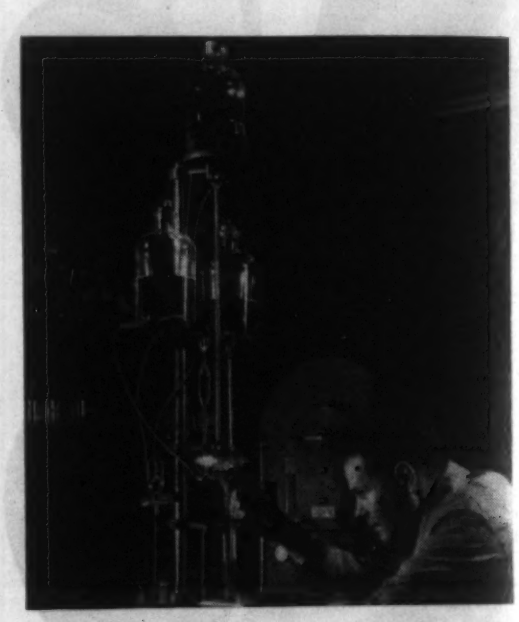
1104 Empire Building . . . . . Pittsburgh, Penna.

HYDRAULIC PRESSES • ROLLING MILL MACHINERY


● The "Kleer-Vu" envelope, made of cellulose acetate plastic, is designed as a protective covering for work orders, blueprints, maps, charts, diagrams and all other factory and office forms. It will not tear or break; the binding will not unravel; it is flame, moisture and oilproof. It is made by *American Plastics Products,* 553 S. Western Ave., Los Angeles 5.

## Rapid Sulphur Determinator

For rapid and accurate sulphur determination of all steel, iron, non-ferrous metals and other materials, the *Harry W. Dietert Co.,* 9330 Roselawn Ave., Detroit 4, has put out the Three Minute Sulfur Determinator. The sample is ignited in a high temperature furnace in an oxygen atmosphere, where sulphur dioxide gas results.

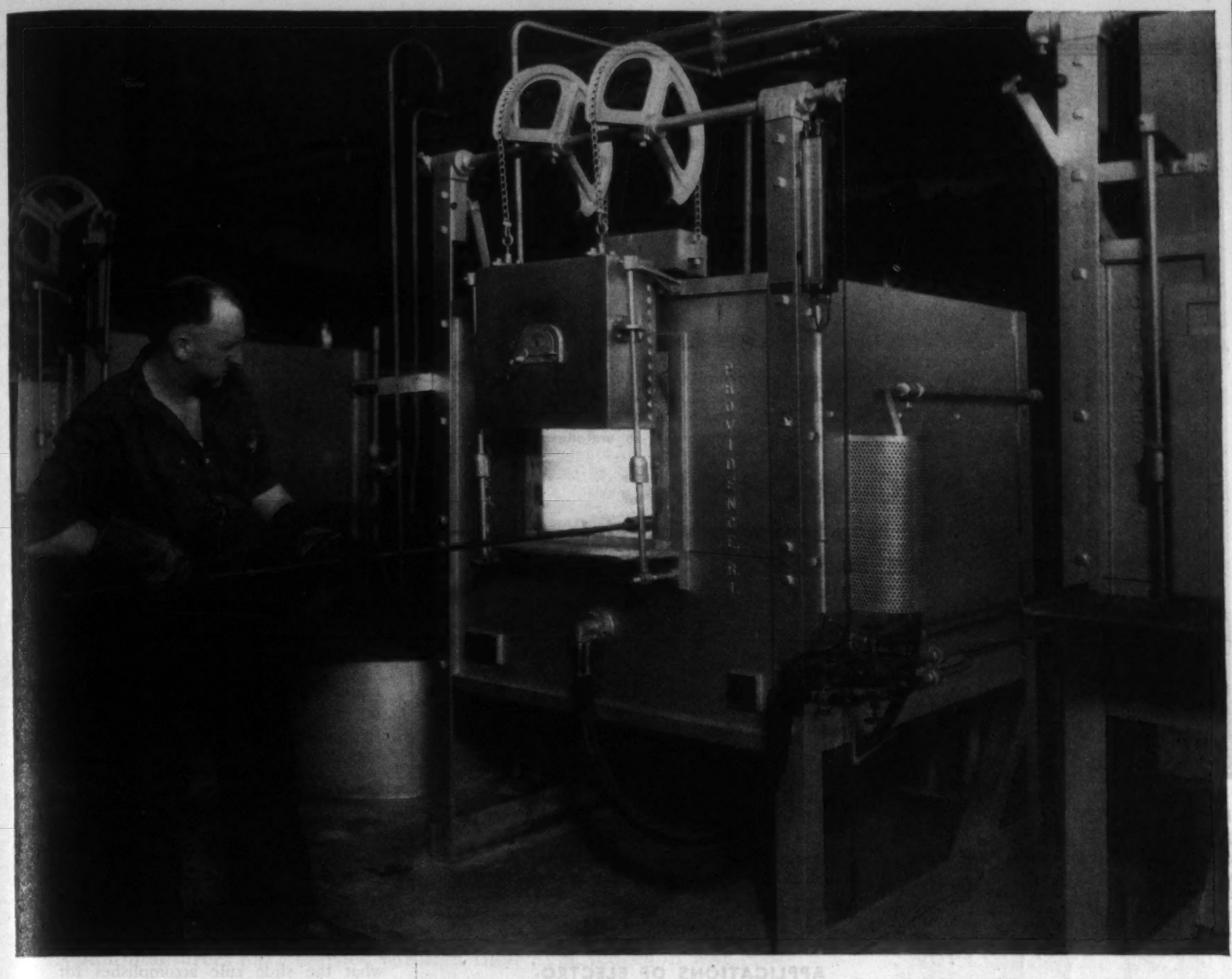


Dust is filtered out, then the gas bubbles through an alkaline solution that reduces the alkalinity of the solution. The greater the sulphur, the lower the alkalinity, the latter being measured by titrating with a standard acid solution.

Measuring burettes with 2 litre solution bottles are mounted in one unit, a second unit consisting of a stand and support for holding the solution vessel at the furnace. Thus, one sample is in process of combustion, another in titration.

The percentage is read direct from the burette scale. A special blue reflector with a frosted glass base causes the end point to be a distinct color change from yellow to blue.

● A new gage for the instantaneous measuring of pipe consists of two pivoted steel plates with edges curved at three points for contact with the pipe, together with a scale that registers the size of the inside diameter and the drill size for tapping. It is necessary to contact only a small section of the pipe. It is made by *Three-Point Gage Co.,* 3821 Broadway, Chicago.



## Score "Globar" heating elements with an important "assist"!

One of the real factors contributing to the decided success of this type of electric furnace is the "Globar" Heating Element. "Globar" provides a constant, dependable, economical source of heat.

Combined with the advanced design, construction and exclusive heat treating features of this furnace, "Globar" Elements help to make possible a precise control of temperature and atmosphere.

They provide a means for quick temperature rise when needed, thus increasing the actual productive capacity of the furnace. And it has been definitely proved, time after time, that electric heat in the treatment of tool steel assures maximum, uniform hardness—assures the elimination of the hazards of scaling, soft skin, pitting, thus reducing rejects and improving quality.

In electric furnace heat treating you can definitely score "Globar" with an important "assist." Complete engineering data on "Globar" Electric Heating Elements for a wide range of applications sent on request. The Carborundum Company, Globar Division, Niagara Falls, N. Y.

**Globar Heating Elements by CARBORUNDUM**

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## Visual Grinding Gage

A new visual grinding gage is applied to and taken off the work while the machine is in operation, thus eliminating hand "miking." Called the Stuart Micromatic, it is distributed by *Clawson & Bals, Inc.*, 4701 W. Lake St., Chicago.

The dial indicator guides the operator as the work is ground to size. Grinding tolerances of ± 0.0001 in. are easily maintained.

The gage has no gears, levers or angles. The dial is actuated by direct parallel thrust. Contact points of the caliper measuring bar are of tungsten carbide.

Made in two models, the gage has ranges of ⅛ to 1¼ in. and ⅝ to 2½ in., respectively. Additional calipers for the larger model provide ranges of 2 to 5 in. and 5 to 8 in., respectively.

● A grinding machine that puts maximum precision into diesel engine crankshafts and that is the largest of its kind in the country has been installed at the *Baldwin Locomotive Works*, Philadelphia. Built by the *Landis Tool Co.*, Waynesboro, Pa., it can handle shafts up to 216 in., has a swing of 40 in. and can grind shafts for engines from 4 to 12 cylinders. It is driven by two motors, a 30 h.p. wheel drive and a 7½ h.p. traverse drive.

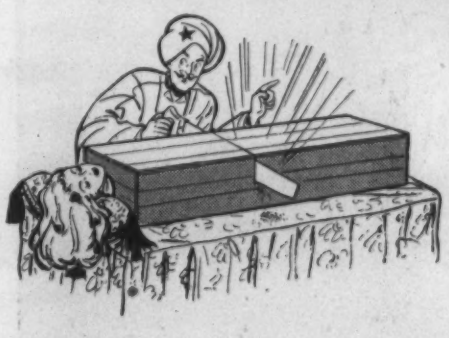
## Electroplating Computer

An original aid to the electroplater and plating chemist that "does for the plater what the slide rule accomplishes for the engineer" is called the Jernstedt Electroplating Computer. It is made by the *Hanson-Van Winkle-Munning Co.*, Matawan, N. J.

The instrument is listed as accomplishing nine functions, including the following: Computes chemical additions required, indicates weight of metal deposited on unit area, lists cathode efficiencies of all solutions, gives plating time required for a given thickness, computes current density needed, and indicates thickness of deposit.

Also, space is provided for recording the standard composition of 20 different plating solutions. It lists component parts, in percentage by weight, of salts commonly used in electroplating, and lists commonly-used metric conversion equivalents.

● A feature of the new cartridge for the .30 caliber Winchester carbine is that the primer leaves a protective deposit in the bore, so that gun barrel cleaning has been reduced to a minimum. Only once a day does the barrel require cleaning because of corrosive action of the atmosphere. The bullet is sheathed with "clad metal," a copper-clad steel made by rolling a copper alloy on both sides of a hot sheet of special drawing steel, states Thomas I. S. Book, *Winchester Repeating Arms Co.*, New Haven, Conn.



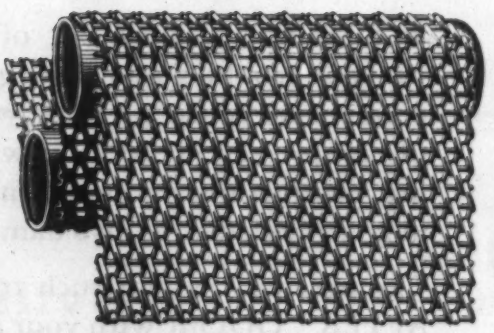
*"That's what W. S. Conveyor Belts do to our costs."*

# Is cutting costs in your Postwar Plan?

Many manufacturers have learned through their experiences in war production that Wickwire Spencer Flexible Metal Conveyor Belts provide an effective means of cutting costs. In their experience lies the key to cutting peacetime costs for many industries.

Each Wickwire Spencer Conveyor Belt is custom-engineered to meet specific requirements. They are built to operate efficiently at temperatures ranging from - -40° F. to 2100° F. or to withstand chemical action or other destructive forces.

A Wickwire Spencer Flexible Metal Conveyor Belt will help reduce handling costs, increase production and achieve more uniform results. Write for our valuable reference book showing types and advantages of numerous conveyor belt constructions and weaves. Also pictures of many actual installations. Address Wickwire Spencer Steel Co., 500 Fifth Ave., New York 18, N. Y.



**FLEXIBILITY?** Wickwire Spencer Conveyor Belt construction permits operation over small diameter pulleys, insuring extreme flexibility and economy in design.

***WHERE THEY ARE BEING USED***

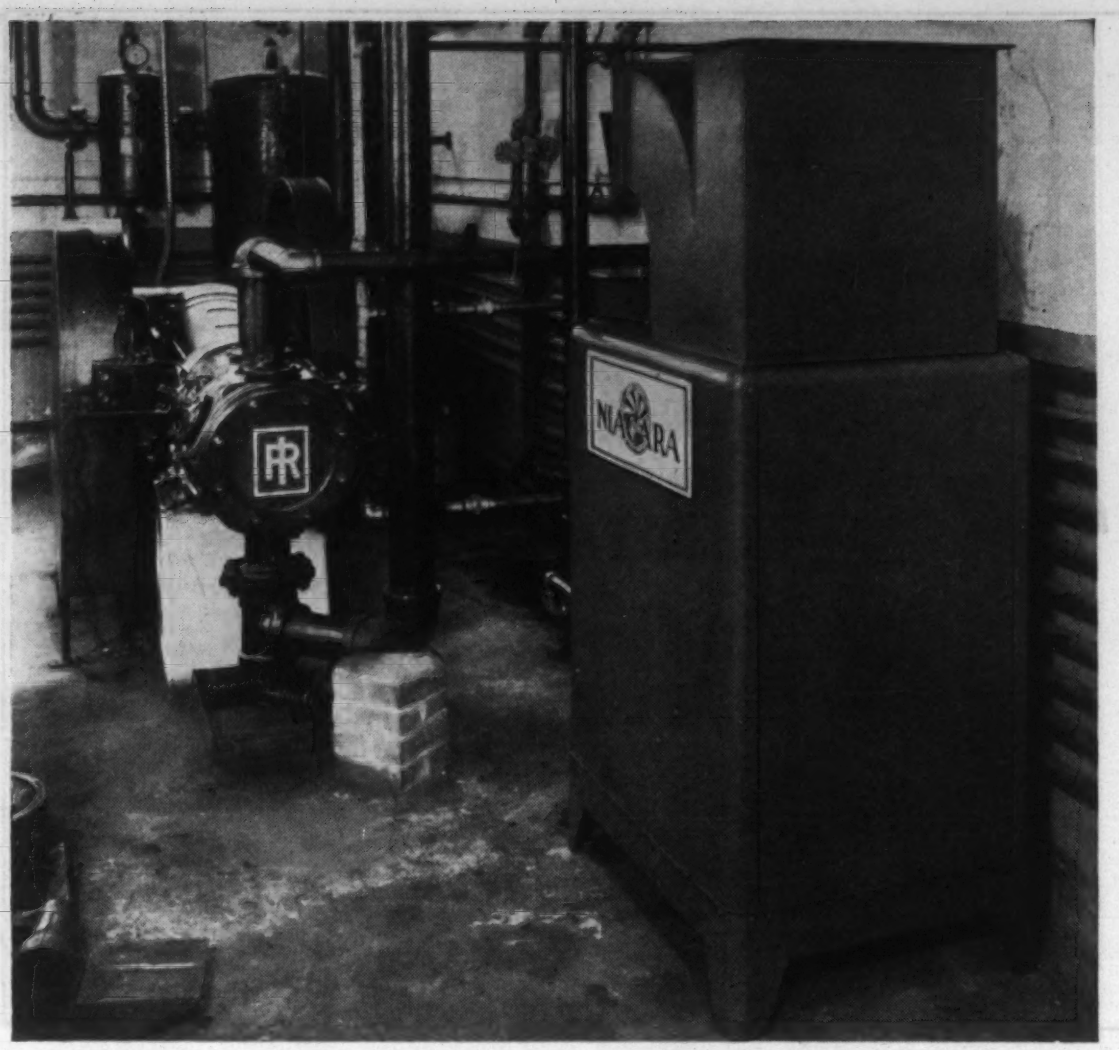
Annealing Ovens — Baking Ovens
Hardening Furnaces — Brazing Furnaces
Degreasing — Dehydrating Food
Canning Operations
Chemical Processing
Decorating Glass, Ceramics
Reclaiming Tin, Rubber, etc.

*Send your conveyor belt questions to:*

**WICKWIRE SPENCER STEEL COMPANY**

**500 FIFTH AVENUE, NEW YORK 18, N. Y.**

**Abilene • Buffalo • Chattanooga • Chicago • Detroit • Houston • Los Angeles • Philadelphia • San Francisco • Tulsa • Worcester**




# Better COMPRESSED AIR After-Cooling

● Keeping moisture out of compressed air is the best way to prevent troubles and damage to pneumatic equipment. Water, condensing in the air lines, wears out and rusts out the vital parts of compressed air tools as well as freezing up air lines and delaying production. In many industrial uses excess moisture or oil in compressed air is also damaging to other materials or products.

The best way to halt such troubles is to use a NIAGARA Aero AFTER COOLER with your air compressor. By evaporative cooling, using atmospheric air as the cooling medium, it obtains lower temperatures and produces compressed air containing only 1/2 to 3/4 as much moisture as air cooled by conventional methods. At the same time it saves cooling water costs, repays its installation cost quickly. It also provides compressor jacket water at controlled temperatures.

*For complete information, write to*

**NIAGARA BLOWER COMPANY**

*"25 Years of Service in Air Engineering"*

NEW YORK Address: Dept. MA-64
6 E. 45th Street,
New York-17, N. Y.

Field Engineering Offices
in Principal Cities

NIAGARA

INDUSTRIAL COOLING • HEATING • DRYING
HUMIDIFYING • AIR ENGINEERING EQUIPMENT


## Quick-Change Die Cast Machines

Designs of new die casting machines provide for quick change from use with aluminum, magnesium and brass alloys to use with zinc, tin or lead base alloys, a change made in 4 to 5 hr. The machines are made by *Reed-Prentice Corp.*, Worcester, Mass.

Either cold chamber attachment or furnace attachment, as required, may be purchased separately, thereby keeping investment cost to a minimum. The machines are designated as No. 1—½ G. and No. 1—½, the former the aluminum type, and the latter the zinc type.

Among the many improvements are the linkage with electric steel members, nitrided pins and hardened steel bushings; also, the hydraulic circuit to increase the speed of the cycle.

Other features are both manual and semi-automatic control with electric interlock for the operator's safety and to prevent shooting of metal until the dies are securely closed.

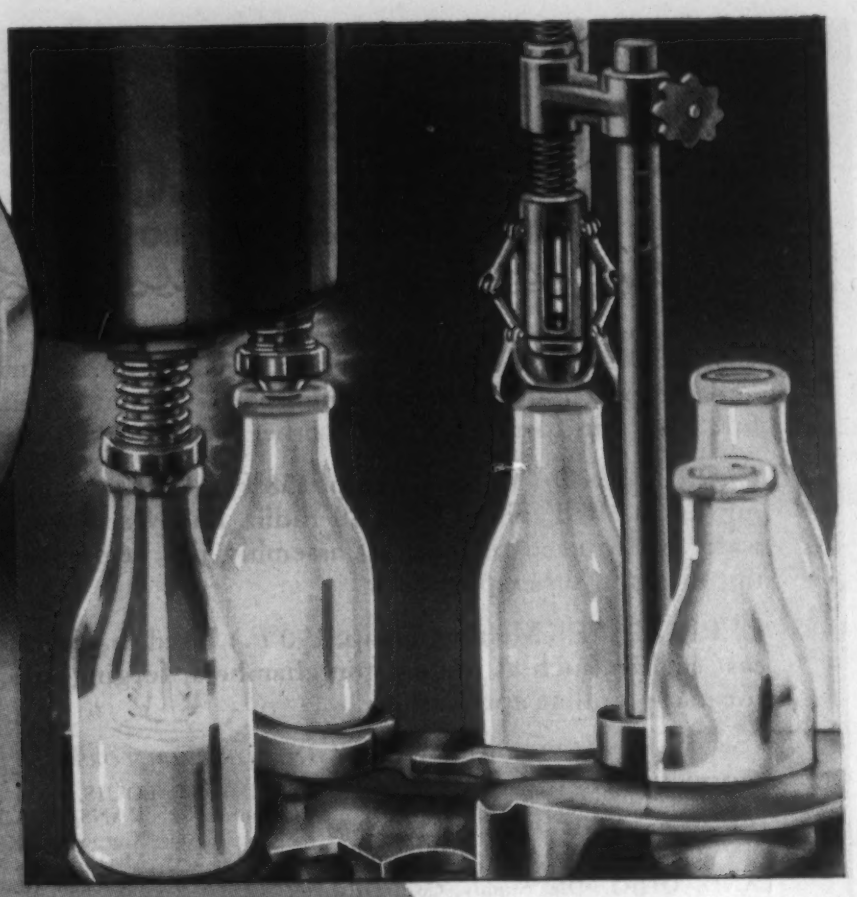
● Three new slide rules have been made available by the *Frederick Post Co.*, Box 803, Chicago 90. One is for the professional draftsman, one for the apprentice draftsman or student, and the third, a handy 5-in. pocket slide rule. All contain the scales A, B, C, D, CI, K, S, L and T. The apprentice rule has a painted face; the other two, celluloid faces.

## Butt Welder for Small Tools

Equipment that extends the application of the band saw butt welder to small tools, broken tools and small miscellaneous welding operations is a new DoAll butt welder, announced by *Continental Machines, Inc.*, 1301 Washington Ave., So., Minneapolis 4.

Steel rods, steel tape, wire and wire forms up to ⅜ in. in diam. are quickly welded. Extensions to drills, screw drivers, small grinding wheels, tape, reamers and cutting tools can be made to order quickly and by experienced operators. It joins all types of band saws up to 1¼ in.

Operation consists of four simple steps. They are produced in both table and pedestal models.



# *Looking For Quick Deliveries of* STAINLESS STEELS?

The Stainless Steel situation has eased. Current deliveries are better than they have been for almost four years. To secure more durable products and reduce replacements, WPB has approved Stainless Steels for certain additional civilian applications.

This metal of many uses is being demanded for many essential industries, such as milk processing and cutlery, because of a multitude of advantages which substitutes fail to provide — its resistance to corrosion, heat and wear; its easy to clean, non-contaminating qualities; its high tensile strength and wide range of mechanical properties.

Rustless concentrates on Stainless Steels. Our specialized production facilities, research laboratories and complete services are at your disposal.

Quicker deliveries of Rustless Stainless Steels can now be made. May we quote on your requirements?

**RUSTLESS**

*Producing* STAINLESS STEEL *Exclusively*

RUSTLESS IRON AND STEEL CORPORATION BALTIMORE 13, MD.

SALES OFFICES: BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DETROIT • LOS ANGELES • NEW YORK • PHILADELPHIA • DISTRIBUTORS IN PRINCIPAL CITIES

*In War, as in Peace . . .*

**CERRO ALLOYS**

**SAVE TIME and CUT COSTS!**

CERROMATRIX (Melting Temp. 250°F.) For securing punch and die parts, anchoring machine parts without expensive drive fits, short run forming dies and other metal-working applications.

CERROBEND (Melting Temp. 158°F.) Used as a filler in bending thin-walled tubing to small radii. Easily removed in boiling water. Also used for aircraft assembly jigs, templates for forming dies and other purposes.

CERROSAFE (Melting Temp. 190°F.) Used to accurately proof-cast cavities such as molds, gun chambers, forging dies, etc., and for many similar applications.

*REPRESENTATIVES AND DISTRIBUTORS*

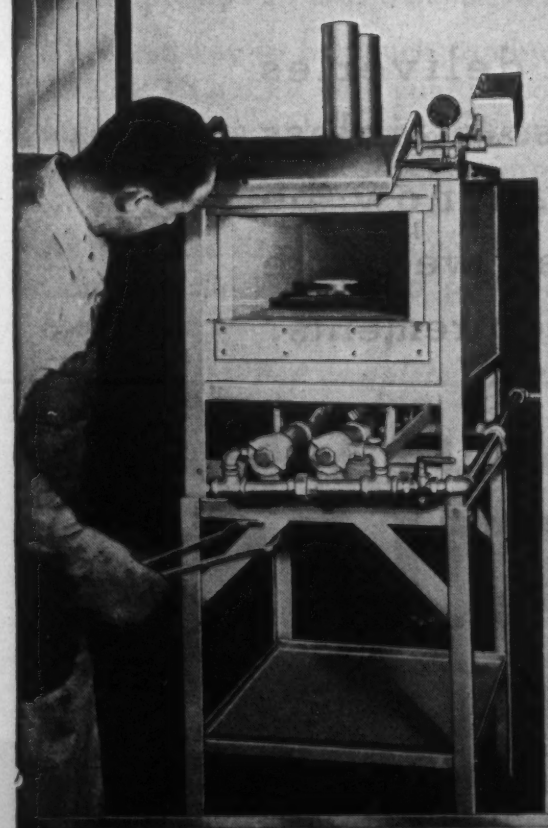
BROOKLYN, N. Y., Belmont Smelting & Refining Works; ANSONIA, CONN., Jackson Associates; BOSTON, MASS., Jackson Associates; PHILADELPHIA, PA., Castaloy Metal Sales Co.; CLEVELAND, OHIO, Die Supply Co.; DETROIT, MICH., Castaloy Metal Sales Co.; CHICAGO, ILL., Sterling Products Co., Inc.; MOLINE, ILL., Sterling Products Co., Inc.; MILWAUKEE, WIS., Harry C. Kettleson, Inc.; MINNEAPOLIS, MINN., Northern Machinery & Supply Co.; ST. LOUIS, MO., Metal Goods Corporation; KANSAS CITY, MO., Metal Goods Corporation; NEW ORLEANS, LA., Metal Goods Corporation; DALLAS, TEX., Metal Goods Corporation; HOUSTON, TEX., Metal Goods Corporation; LOS ANGELES, CAL., Castaloy Metal Sales Co.; TULSA, OKLA., Metal Goods Corp.; MONTREAL, CAN., Dominion Merchants Ltd.; LONDON, ENG., Mining & Chemical Products, Ltd.

**CERRO DE PASCO COPPER CORPORATION**

**40 WALL STREET NEW YORK 5, N. Y.**

**Baker Gas Furnaces**

**TEMPERATURES UP TO 2400° F. WITHOUT A BLOWER**



BAKER Blowerless Gas Furnaces are very low in gas consumption, noiseless in operation, reach the required temperature rapidly and are equipped with thermocouple and accurate pyrometer. The research departments of some of the largest corporations have contributed to making their high efficiency possible.

There are 9 standard stock models ranging in size from No. 1 (Bench type), which is 6″ x 8″ x 5½″, to No. 24, which is 12″ x 20″ x 8″ as illustrated. All provide uniform, controlled heat up to 1900° F.

Model No. 5, 6″ x 12″ x 5″, is built especially for treating high speed steel. Gives uniform, controlled temperatures up to 2400° F.

We stock one Hydrogen Atmosphere furnace, No. 12, with a closed muffle 8½″ x 15″ x 2½″ high.

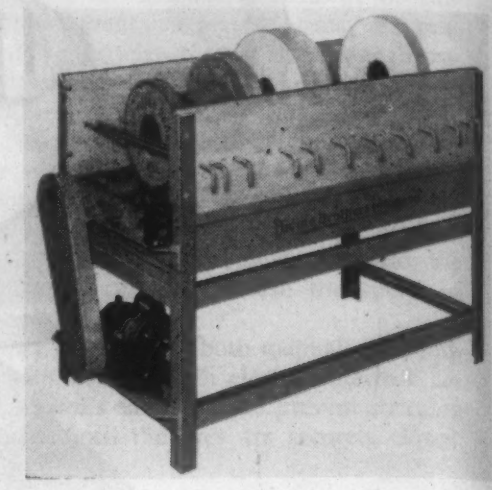
Special size furnaces built to your order. Write for descriptive folder and prices.

**BAKER & CO., INC.**

**113 Astor St., Newark, N. J.**

## Polishing Wheel Washers

A polishing wheel washer, to save time and effort of polishers, save wear and tear on diamonds, and avoid irregular cutting of wheels to re-head them, has been brought out by *Divine Bros. Co.*, 102 Whitesboro St., Utica, N. Y.



It extends wheel life by uniform head removal via the wet method. It is particularly adapted to leather-covered wood (strap faced) wheels.

It can be plugged into any electric outlet. Several wheels' heads can be gradually and uniformly soaked off at one time. Only the bottom of the rollers is immersed in water, so that the abrasive is removed without injury to the body.

Wheels of different diameters up to 24 in. can be separated by inserting wheel-separating rods. The rollers are driven by ¼ h.p. gear type meter 110/220 v. 60 cycle single phase.

● "Lubricoolant" is a new and superior replacement for the conventional cutting oils and coolants. Made by the *Du Bois Co.*, 1120 W. Front St., Cincinnati 3, it has shown tool life prolongations ranging from 12 to over 60% on metals, from chrome-molybdenum steel to aluminum alloys.

## Testing Shells by Sound Waves

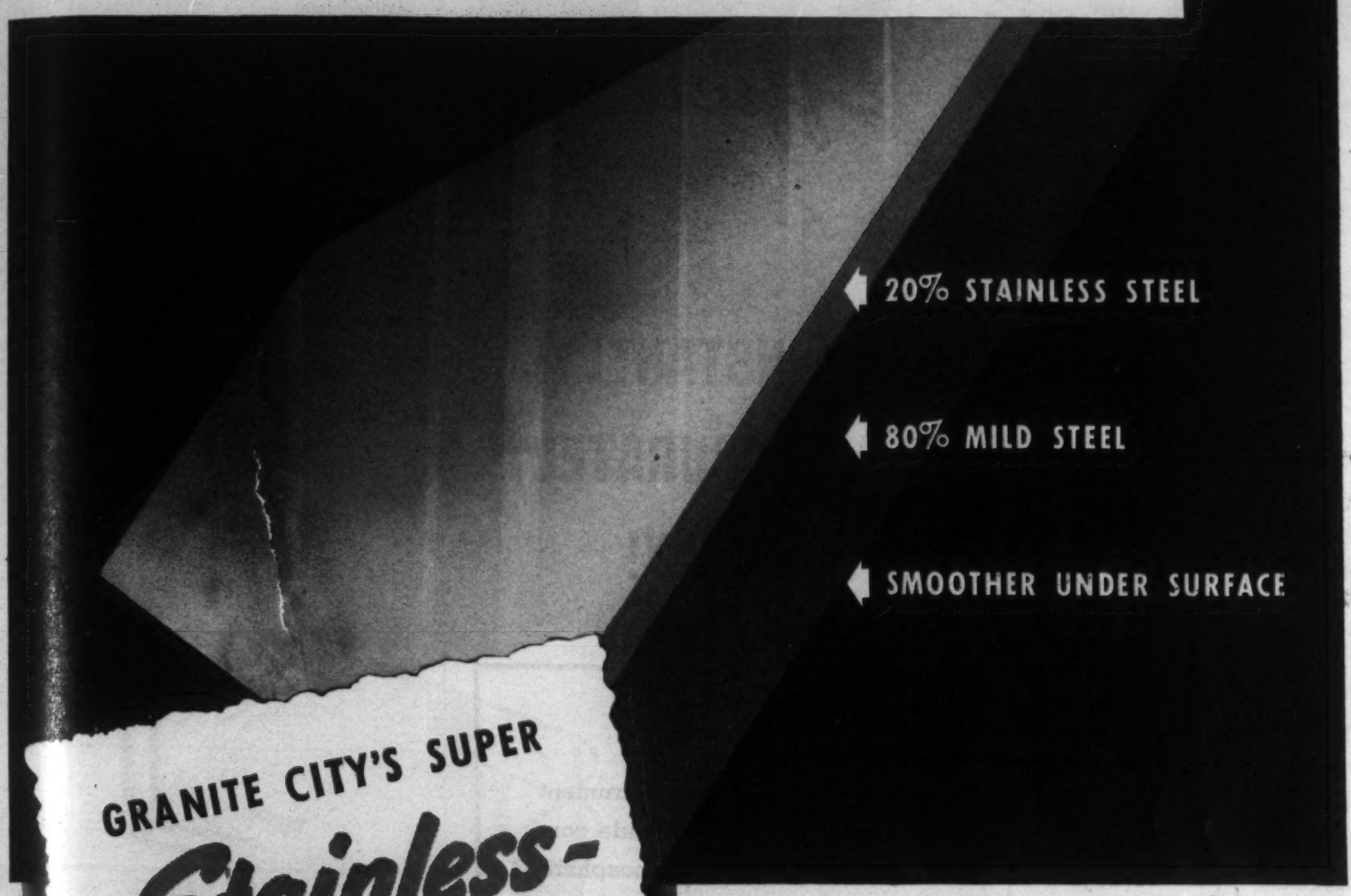
An instrument tests 20-mm. shells by an analysis of sound waves generated by striking or dropping the shell upon an anvil. Even the smallest cracks or defects can be thus detected.

Known as the Sonotest, and sponsored by the *Ordnance Dept., Army Service Forces*, the device originated from attempts to find an automatic method of refusing bad coins and making change for bottled drink vending machines.

This 70-lb. portable instrument distinguishes and measures the frequency of the sound wave, its amplitude and the duration of the sound. The shell is bounced twice upon the anvil, first upon its base and then upon its side.

An inexperienced operator soon learns to inspect 1200 to 1800 shells per hr. A green master indicator light indicates that the shell is acceptable.

## Significant Facts for Postwar Planners...No. 3




GRANITE CITY'S SUPER

# Stainless-Clad

In hundreds of wartime applications, Granite City STAINLESS-CLAD has proven versatile, dependable, economical where resistance to corrosion is needed on one side only. The success of this material in war is significant of the possibilities it holds for advanced products of the future.

20% stainless, permanently bonded to 80% mild steel. Pickled or polished finish. Investigate how Granite City STAINLESS-CLAD can help you develop better postwar products.

### IF YOU ARE LOOKING TO THE FUTURE

*... keep your eye on Granite City!*

66 years of "Tailor-Made" service to industry has accustomed this organization to the problems of changing steel requirements in new products.

Abreast of every new development in steel production, Granite City offers the advantages of strict quality control, coordinated under one of the most advanced laboratories in the steel industry. This rich store of experience and talent is available now to help in the development of your postwar products.

## GRANITE CITY STEEL CO.

Chicago • Cleveland • Denver • Houston • Indianapolis
Kansas City • Los Angeles • Louisville • Memphis • Milwaukee • Minneapolis • Moline • New York • St. Louis

SINCE GRANITE CITY STEEL 1878

Hot Rolled Sheets • Cold Rolled Sheets • Striplates • Tin Plate • Terne Plate • Electrical Sheets • Tin Mill Products • Porcelain Enameling Sheets

# Check ATMOSPHERE—PRODUCER Efficiency

INSTANTLY!
ACCURATELY!
EASILY!

The Engelhard Flualyzer is a highly sensitive instrument particularly adapted to determining the carbon dioxide content of the generated gas in either oil or gas fired atmosphere type heat treating furnaces. Extremely accurate results are obtained by combination of the time-proven Wheatstone Bridge circuit for the analysis of $CO_2$ with the Engelhard Thermocouple circuit for the determination of temperature.

Compact and completely self-contained, the Flualyzer is light-weight, portable, easy to handle. Readings are taken directly from a double range indicator calibrated from 0 to 20% of $CO_2$ and 0 to 1000° F.

A trial will convince you that this modern instrument provides maximum convenience and reliability as a furnace atmosphere test unit.

Write today for details and specific application data.

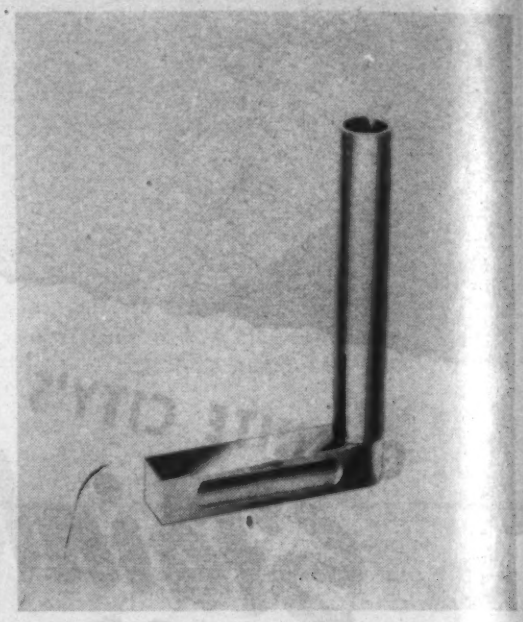
CHARLES ENGELHARD, INCORPORATED
90 CHESTNUT ST., NEWARK, NEW JERSEY


● Separation of scrap lead from copper in lead-covered cables is conducted in a novel manner at the plant of the *Nassau Smelting & Refining Co.,* Totenville, S. I. The scrapped cable is placed on a grating broiler grid, or open mesh, over a huge cast iron pot, under which is a fire. Heated to 600° F., the lead melts off and trickles down into the pot. The copper wire, which melts around 1750° F., is unaffected and is reclaimed later.

## Master Square for Precision

A master square for precision industrial uses that involves a new concept that multiplies the normal life of such a unit many times is announced by *Dearborn Gage Co.,* 22038 Beech St., Dearborn, Mich. The upright member is a cylinder, screwed to the base.

As wear develops, a fresh new surface is brought into use by loosening the screw



and turning the cylinder slightly. The cylinder increases accuracy, since the piece checked cannot help but make proper contact against the rounded surface, or edge.

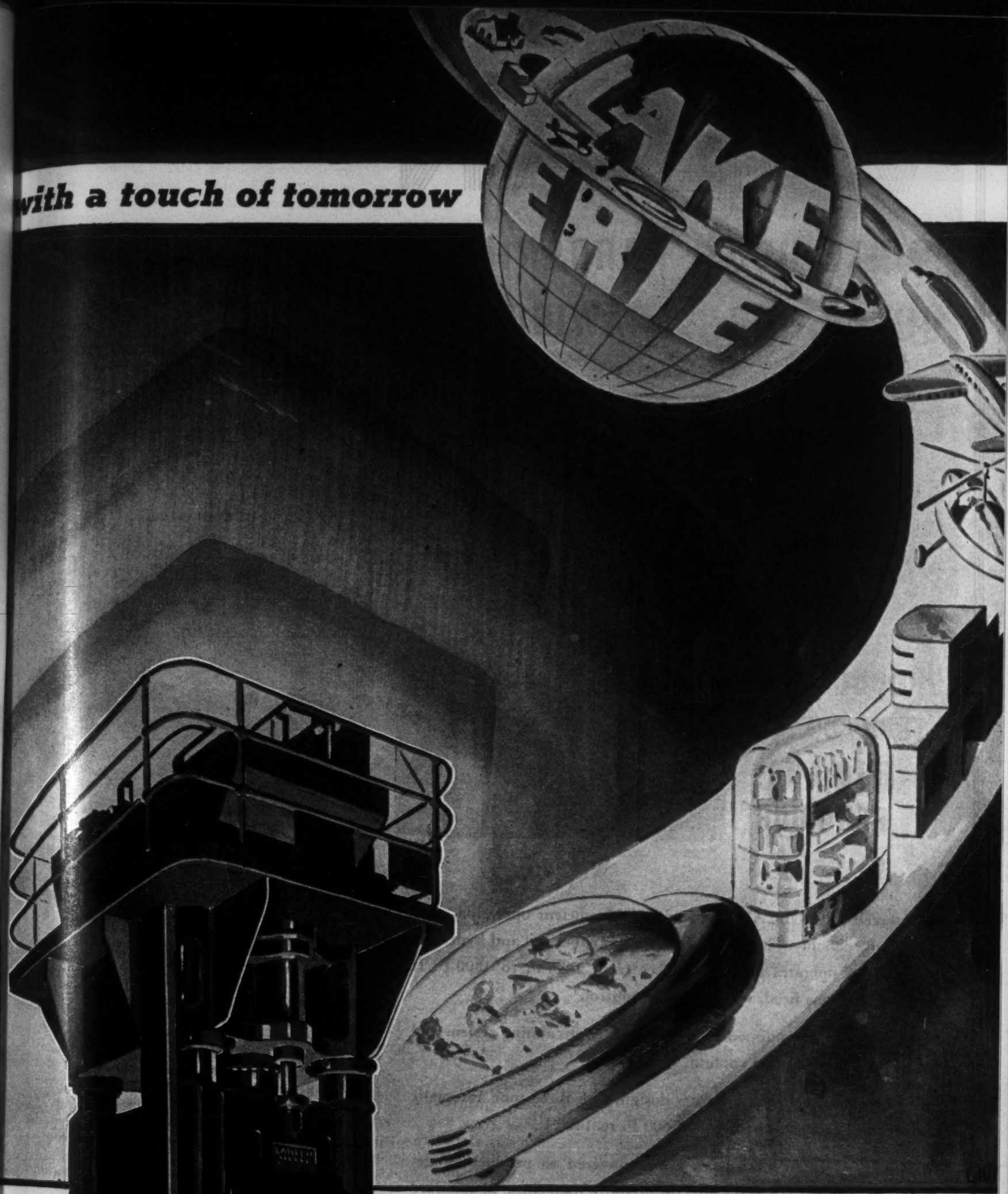
All surfaces are hard chromium-plated and lapped to finish accuracy of 10 microinches. Both upright and base are made of thoroughly-seasoned gage block steel.

It is easy to use because of the broad ¾-in. wide base on which the workpiece can rest. Sizes start at 4 in. (upright measurement from base surface), and can be obtained in larger dimensions.

● A new line of Frostpoint refrigerated resistance welding electrodes with replaceable Frostcaps of Mallory-3 metal is announced by *Frostrode Products,* 19003 John R, Detroit 3. The new caps of high strength and hardness provide increased durability in severe, high production service. The finned internal surfaces of the Frostcap distribute the coolant uniformly. The caps are available in ⅝ and ⅞ O.D.

**with a touch of tomorrow**

LAKE ERIE

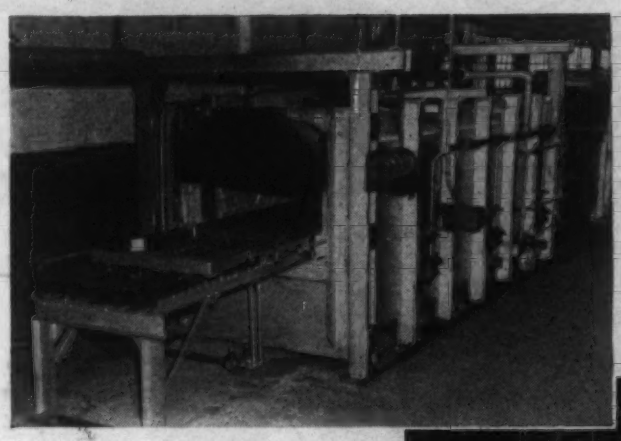


***The advancement in LAKE ERIE Hydraulic Press design should be investigated by those who do the planning for their company's future.***

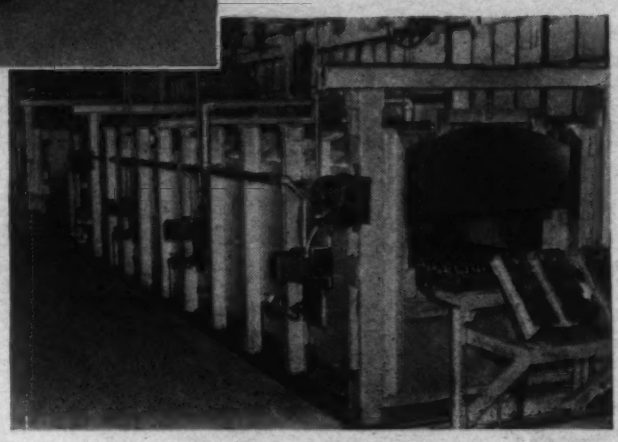
**LAKE ERIE ENGINEERING CORPORATION • BUFFALO 17, NEW YORK**

# VULCAN

## CONTINUOUS HARDENING... QUENCHING... DRAWING UNIT



**For Treating Miscellaneous Forgings and Castings . . .**



**PRODUCTION: 1000 LBS. TO 1500 LBS. PER HOUR**

**Engineered by VULCAN to provide fast, efficient operation, with maximum economy. Hardening furnace has roller rail and hydraulic pusher, and operates at temperatures from 1400°F. to 1800°F. It may be oil or gas fired, with two-zone control.**

**Quenching unit is equipped with conveyor, re-circulating system and automatically controlled cooling.**

**Draw furnace is roller rail, pusher design, with three-zone automatic temperature control, operating at 600°F. to 1400°F.**

**Although VULCAN Furnaces are engineered to produce predetermined results, they generally cost no more than those of standard design. Inquiries regarding your heating or heat treating needs will receive prompt attention.**

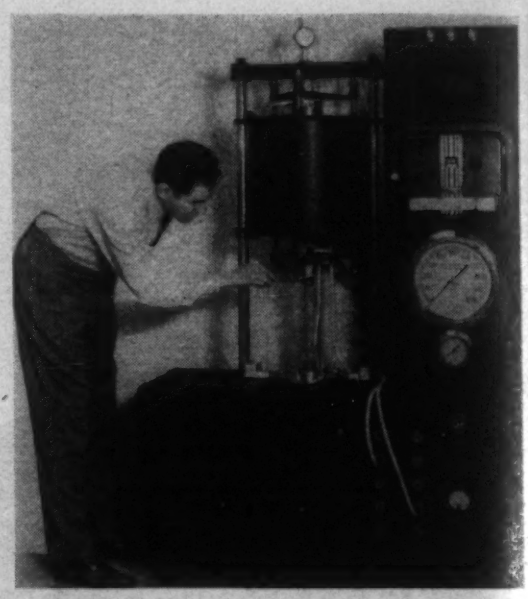
**VULCAN CORPORATION**
**1791 CHERRY STREET, PHILADELPHIA, PA.**


● A disconnecting, self-sealing coupling, able to withstand 2500 p.s.i. after mere finger-tightening, is introduced by *American Screw Products,* 7000 Avalon Blvd., Los Angeles 3. The aluminum alloy body prevents distortion, with no jamming of the spring-loaded shut-off valve. Springs are of heat-treated steel; lightweight cast phenolic poppets are positive-sealing.

## Dilatometer for High Temperature Testing

For high temperature testing of foundry molding and ceramic materials, an improved Dilatometer has been brought out by *Harry W. Dietert Co.,* 9330 Roselawn Ave., Detroit 4. Included is a furnace with range of 500 to 3000 F.

A test specimen, usually 1⅛ in. in diam. and 2 in. long, is loaded in the furnace by



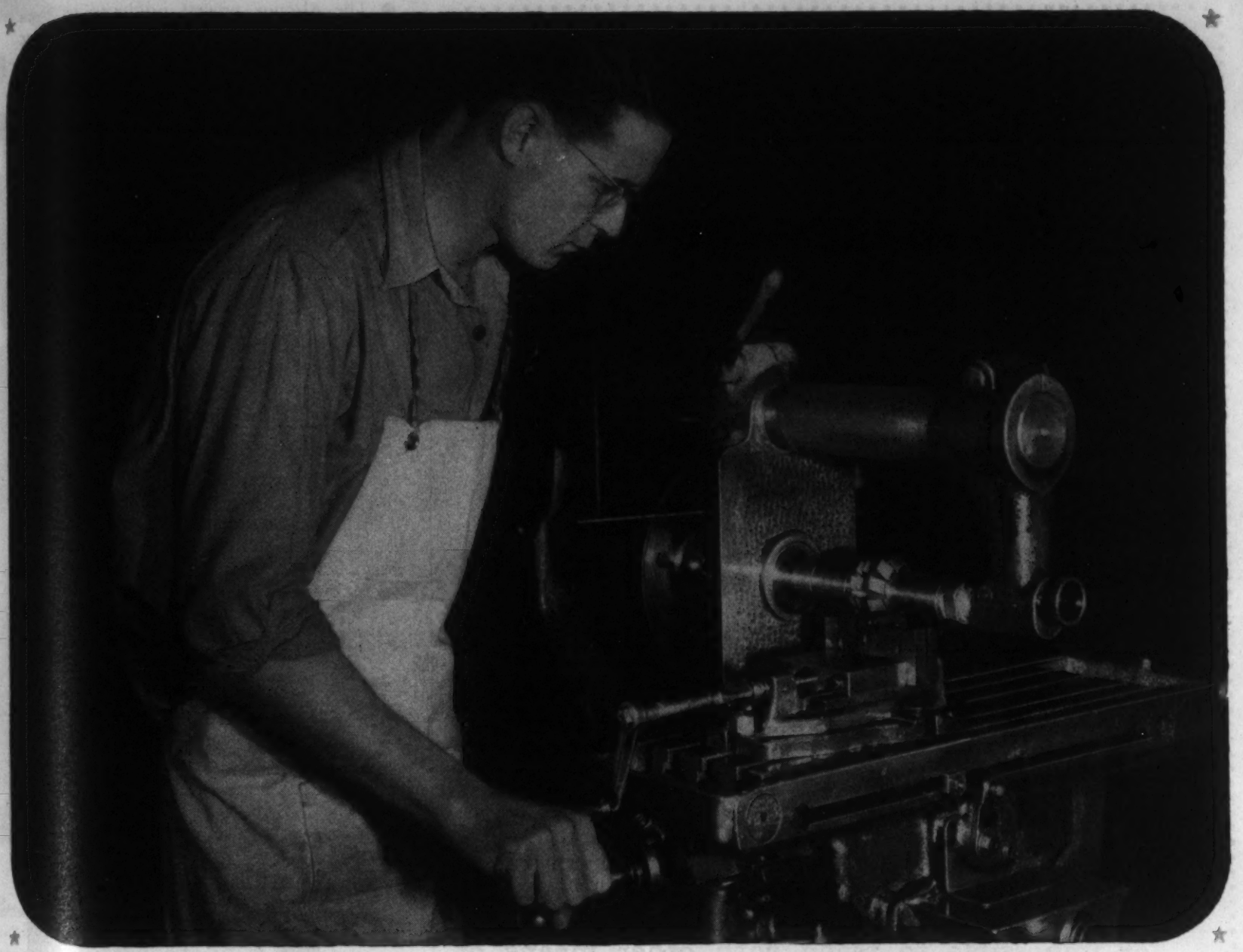
a motor-driven, hydraulic plunger that may be used to load the specimen in compression for determining hot strength at elevated temperatures. Compression strength is recorded on a large test gage.

Expansion or contraction of the specimen is readily obtained either for thermal shock or gradual temperature rise. Both free and confined tests are permissible. The unit lends itself to spalling tests for either shock or gradual temperature immersion.

Accessories are available to measure the hot permeability of materials at elevated temperatures. Gas pressure created by materials at elevated temperature is also measured.

Also with accessories one can test metal penetration, veining and grooving, and the facing or protective value of various foundry or glazing materials.

● A new alkali cleaner for brass cartridge cases has been brought out by *Nielco Laboratories,* 19720 Florence Road, Detroit 19. Known as Nielco Lab. No. 1919, it is a free-flowing powder, readily soluble in warm water, giving off no harmful vapors and so low on sodium oxide as to be harmless to skin and clothing. It has other uses, including cleaning of steel, tin and stainless steel.



# *Check these Main Points*

## WHEN YOU'RE MACHINING STAINLESS STEEL

**Have you a copy of the Allegheny Ludlum "Fabrication Blue Sheet"?**

Contains a wealth of reliable, certified data, not only on the machining of Allegheny Metal, but on the best methods employed in other fabrication operations on stainless steel—forming, welding, finishing, etc. Write for your copy—you'll find it highly useful and complete.

**ADDRESS DEPT.** MA-23

COME war or peace, stainless will always be a critical material *in the shop.* You'll want to keep rejects and spoilage low, as well as machining time and cost—and there are ways to do it.

Cutting speeds can't be as fast as with carbon steel or low alloys. Tools should be high speed steel or carbide-metal tipped, with a generous rake and a chip breaker, if possible. Keep them sharp, and don't allow the tool to ride on the work, to avoid work-hardening.

More important, check the design of the cutting tool itself, and check the possibility of using one of the special easy-machining grades of Allegheny Metal. Let us help you also to select the right cutting tool from the complete range of Allegheny Ludlum High Speed Steels and Carmet Carbide Tools.

AL — STEEL FOR THE NATION'S WELFARE

**Allegheny Ludlum**
**STEEL CORPORATION**
GENERAL OFFICES: BRACKENRIDGE, PENNA.

A-9294 ... W & D *Branch Offices in Principal Cities . . . Allegheny Metal also handled by all Joseph T. Ryerson & Sons, Inc. Warehouses*

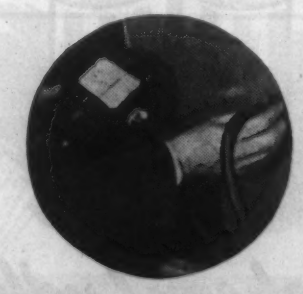
CHECK
BLOWERS
AND EXHAUST
SYSTEMS
*Instantly*
with the **Alnor** Velometer

**This instantaneous direct reading air velocity meter measures air speed in feet per minute. There are no calculations, no timing, no conversion tables; its use is so simple that anyone can take accurate measurements with the Velometer. Extension jets permit correct readings in many locations that would be difficult or impossible to reach with other means of measurement.**

**Keep exhaust equipment working efficiently by regular checks for draft, leaks, blower operations, etc., with the Alnor Velometer. You can get accurate information on performance with a few minutes' inspection at regular intervals.**

**The Velometer is made in several standard ranges from 20 fpm to 6000 fpm and up to 3 inches static or total pressure. Special ranges available as low as 10 fpm and up to 25000 fpm velocity and 20 inches pressure. Write for Velometer bulletins.**

Velometer used for positive static pressure readings



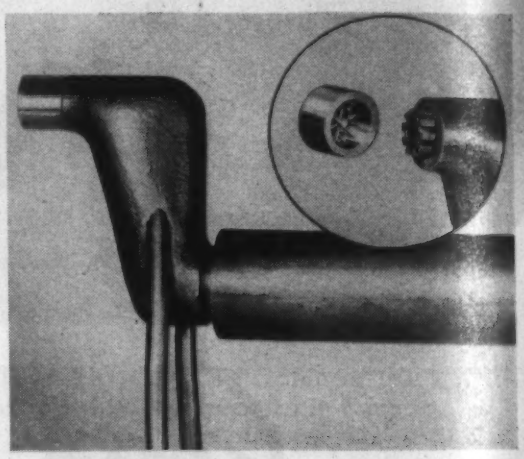
**ILLINOIS TESTING LABORATORIES, INC.**
**420 North La Salle Street**
**Chicago 10, Illinois**


● The Alronox process produces an even black corrosion resistant finish on zinc or zinc alloy surfaces. Made by the *Alrose Chemical Co.*, Providence, it is easily applied by immersion. It can be applied within a 7-min. cycle, is non-electrolytic, and has a salt spray rating of 200 to 300 hrs. on 0.0002 zinc plate over steel, without after-coating. It is a good base for organic coatings, and will not chip or peel.

## Offset Tip-Cooled Electrode

The first offset spot welding electrode that can be effectively cooled at its tip is introduced by *Frostrode Products,* 19003 John R St., Detroit 3, the first application being in the fabrication of aircraft sub-assemblies.

Previously, it was impossible to provide efficient electrode cooling in hard-to-get-at positions, such as spots close to flanges, since internal water passages could not be extended to the tip without dangerously weakening the "knee."



But in the new product maximum strength is retained by having a solid cross section at the point of greatest stress. The liquid enters the offset electrode below the knee, flowing through the coolant guide into the finned, replaceable "Frostcap" that forms the tip.

The offset electrode is adaptable to any standard holder. Cooling is carried to within a fraction of an inch of the welding face. Results include less pick up, increase in output speed, and decrease in cleaning time.

● A small quantity of simplified electron microscopes will soon be shipped on high priority orders to industrial laboratories and colleges by *General Electric Co.*, Schenectady. This design employs electrostatic lens that do not require accurate voltage regulation. It operates on ordinary house current, produces images 10,000 times the size of the specimen, and is 10 times more powerful than the best light microscope.

# R-301 the ALUMINUM ALLOY that has both STRENGTH and RESILIENCY

**R-301,** THE NEW REYNOLDS-DEVELOPED ALUMINUM ALLOY, combines high strength and resiliency for the first time. Elasticity and thermal conductivity, so vitally important in absorbing kinetic energy without fracture, are inherent properties of this latest Reynolds triumph of metallurgy.

Tests with armor-piercing shells have proven that *pound for pound* R-301 surpasses former armor metals . . . and that's why new fighting planes are protected with this latest Reynolds aluminum alloy.

*R-301 is the first high-strength aluminum alloy* that has a hard core as well as a tough surface cladding . . . with a corrosion resistance almost as good as 99.5% aluminum! The cladding is more homogeneous in relation to the core, and this adds still other important advantages—higher bearing, shear, yield and fatigue strengths.

*R-301 is more workable* than previous high-strength aluminum alloys. From the initial die stampings right down to the final fabrication, R-301 speeds production and cuts spoilage.

*R-301 is being produced in three tempers,* suitable for a wide range of structural and industrial applications. Write for full information. Reynolds Metals Co., Aluminum and Parts Div., Louisville, Ky.

R-301 is so tough it is used as armor on the new fighting planes. Pound for pound it surpasses former armor-plating metals.

R-301 being tested for hardness. It has a tough cladding as well as a strong core . . . and a corrosion resistance almost as good as 99.5% aluminum.

REYNOLDS METAL

# REYNOLDS ALUMINUM

*The Great New Source of*

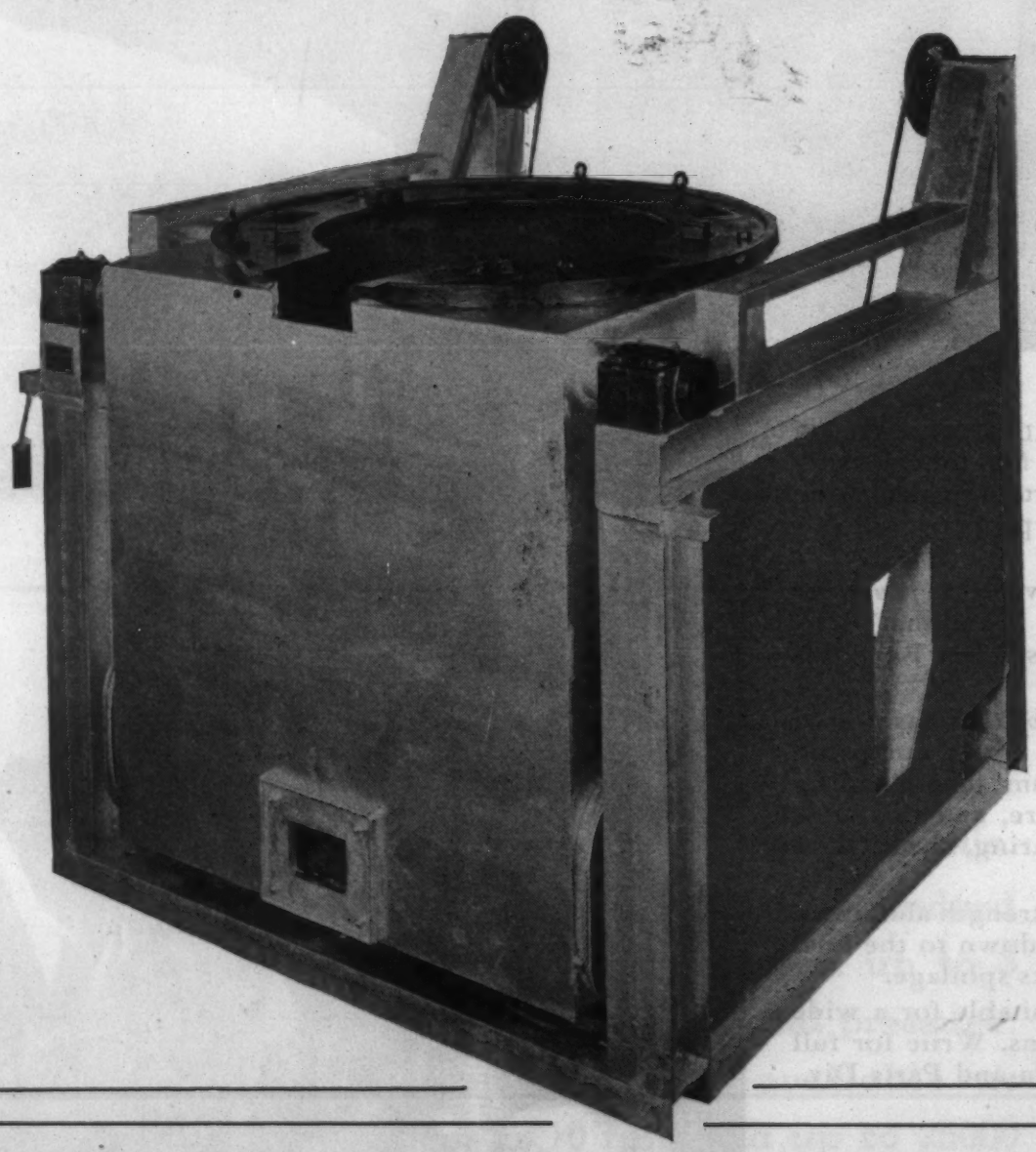
INGOT • SHEET • EXTRUSIONS • WIRE • ROD • FORGINGS • TUBING • FOIL • POWDER

# MONARCH OF THE SHOW!

## *for* Magnesium

## *and* Aluminum

- MOTORIZED NOSE POUR
- HAND TILTING
- STATIONARY



**THE MONARCH ENGINEERING AND MANUFACTURING CO.**

Curtis Bay Baltimore, Md.


## Production High Frequency Heating

The first production line process of high-speed continuous heat treating, using Megatherm high frequency energy, has been established by the *Industrial Electronics Div., Federal Telephone and Radio Corp.*, Newark, N. J., manufacturing associate of the International Telephone and Telegraph Corp.

The application was to finish bearing pins, each 2½ in. long by ½ in. diam., case hardened to a depth of 0.025 in. as they were fed automatically through a glass tube and water quenched as they left the

heating coil at the rate of 75 pins per min.

Such heating is the only process known capable of this. Employing five megacycle energy, the surface of each part was heated above its critical temperature in less than one sec. Due to the high speed with which the heat was applied to the surface, there was insufficient time for it to penetrate into the core and, hence, only a thin surface layer experienced a change in physical state, the central portion retaining all original toughness and strength.

The following equipment is involved: The hopper from which the unhardened parts are fed into the glass tube; the heating coil; the Megatherm induction unit, made by Federal; a connection providing a continuous flow of water for quenching, and a work table carrying suitable containers for the finished and hardened product as ejected from the heating fixture.

Surface hardness became Rockwell C 60—above file hardness. The metal was chromium molybdenum steel NE-9442. The pins were finish ground prior to heat treating, and after the hardening there was no scale or warpage. This was due to high speed of the process, which for the first time in the history of the machine tool industry, makes possible the surface hardening of parts after finish grinding. Thus, tremendous savings are effected.

The coil used here is a single layer approximately 1 in. long by ¾ in. in diam., consisting of five turns of small copper tubing. The coil is grounded and does not carry high voltage. It is exposed to continuous wetting by the water used for quenching.

The microphoto (100X) shows a highly magnified view of the hardened surface as

(*Continued on page* 1570)

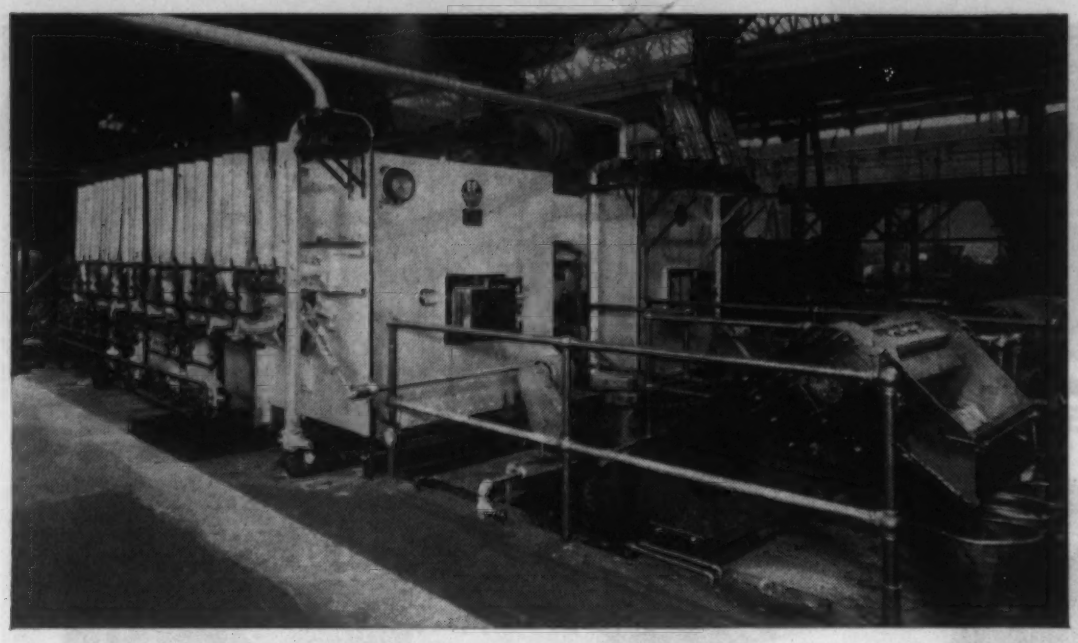
# FREE BOOK tells how to be sure your extinguishers are ready!

Your fire extinguishers are *first aid* equipment. They must be ready to nip fires quickly — and that means they must be in top form *at all times*. Regular inspection is the only sure way to keep them in condition.

The booklet shown here has just been issued by Walter Kidde & Company to help you set up a fire extinguisher maintenance system. It covers all types of equipment, gives *specific* instructions. Write for your copy of this free booklet today!

Kidde

WALTER KIDDE & COMPANY, INC., 140 CEDAR STREET, NEW YORK 6, N. Y.



# EF Gas Fired Radiant Tube Chain Belt Conveyor Furnaces

## For Scale-Free Hardening Miscellaneous Products 175 to 2000 lbs. per hour—continuously.

The above gas fired radiant tube furnace is one of three chain belt conveyor type furnaces we installed in one prominent midwestern plant for scale-free hardening small and medium size products. These continuous chain belt conveyor furnaces may be oil fired, gas fired or electrically heated. They are built in 5 standard sizes with capacities ranging from 175 to 2000 lbs. per hour. Larger or smaller sizes can also be supplied. Any size or type can be furnished for using special protective atmospheres for heat treating without scale or decarburization.

*Products being treated in EF Chain Belt Furnaces include:*

Sprockets
Cap Screws
Bolts and Nuts
Gears and Pinions
Flat & Coil Springs
Small Forgings
Valve Springs
Spring Plates
Tractor Links
Automotive Parts
Wrench & Tool Parts
Rivets and Washers
Bearing Parts—cups and cones
Machine Gun Cartridge Clips
Aircraft Engine Parts
Rock Bits, etc.

EF Chain Belt furnaces are handling all kinds of parts and products ranging in size from small bolts and springs up to large crawler links for tanks and tractors. Hundreds of these furnaces are in operation handling such products as listed at left. The conveyor type furnace is one of the most satisfactory and dependable general purpose heat treating machines built for the continuous, uniform, economical, production heat treatment of miscellaneous small and medium sized parts and products.

The chain belt conveyor furnace is only one of the numerous types we build. Castings, forgings, stampings, aircraft and aircraft engine parts, tank and truck parts, tubing, wire, strip, and many other products are being uniformly treated in other types of production furnaces we have built.

*Telephone 4661 Salem, Ohio, or write us regarding your furnace problems. We specialize on building production furnaces—oil fired, gas fired, or electrically heated.*

Send for circulars showing the chain belt and other types of EF production furnaces.

**The Electric Furnace Co., Salem, Ohio**

Gas Fired, Oil Fired and Electric Furnaces---For Any Process, Product or Production

# FURNACES OIL, GAS or ELECTRIC

## For Every Heating and Heat Treating Process

Aluminum Brazing
Annealing
Billet Heating
Bright Annealing
Bright Hardening
Copper Brazing
Controlled Atmosphere
Carburizing
Drawing
Enameling
Forging
Hardening
Malleablizing
Silver Soldering
Nitriding
Normalizing
Soaking Pits
Scale-Free Hardening
Quenching Machines
Ceramic Kilns, etc.
Process Heating

*We Build the Furnace to Fit Your Job*

**THE ELECTRIC FURNACE CO.**

SALEM, OHIO


developed on the bearing pin. The white portion is that of the hardened outside case, and it will be observed that it extends 25 thousandths of an in. beneath the surface.

Of this 25 thousandths, there is no visible change in the structure or depth of approximately 15 thousandths of an in. From this depth in, there is a slight change in the apparent structure in the material, but there was no measurable loss of hardness. The dark portion is the unaffected core material.

At no point in the transition zone from fully hardened case to the dark unaffected core material was there any evidence of softening or tempering of this adjacent internal layer.

● "Insidline," an internal insulation, has been developed to enable ordinary carbon steel pipe to stand up under pressure at temperatures above 1000° F. By holding the temperature of the pipe itself to 650° F. or below, "creep" does not occur, and it can operate indefinitely at the usual stress allowance. It also reduces the number of expansion joints, bends, etc. It is made by *Baldwin-Hill Co.*, 501 Klagg Ave., Trenton, N. J.

## Heavy Duty Steel Heaters

A new heater for heavy duty applications in industrial heating, drying, etc., features addition of fins to the heater pipes, thereby increasing heating capacity ten times. Called "Heavy Duty Steel Heaters," they are made by *B. F. Sturtevant Co.*, Hyde Park, Boston.

They are constructed of 1-in. standard steel pipe threaded into cast iron headers. Inside the 1-in. pipes are ⅜-in. steel pipes that carry the steam from the header, distribute it uniformly to all heater pipes, prevent air binding and provide a non-freeze characteristic.

Wound around the heater pipes are spiral fins made of soft carbon steel strip, 9/32 in. wide and tapered from 0.035 in. thickness at the edge attached to the pipe to 0.012 in. at the outside edge. Tapered fins provide greater heat transfer. Pipe and fins receive a permanent bonding in a metallic bath.

All heaters are subjected to a 600-lb. hydrostatic test and to 200 lb. under steam, a 1000-lb. hydrostatic test being optional.

● Noviweld-Didymium lenses for flame welders are now available in a lighter, or No. 3 shade, from the *American Optical Co.*, Southbridge, Mass., this new shade being useful for working on aluminum. These lenses absorb sodium flare and protect against ultra-violet and infra-red. They preserve orange and red color values.

# the most AMAZING Castable Refractory in Engineering History!

## NEW! Nothing Like Kast-O-Lite

**INSULATION FOR USE TO 2500° F. IN DIRECT CONTACT WITH FLAME**

There is no other castable like Kast-O-Lite. It's INSULATION plus CASTABLE for use in direct contact with flame to 2500°F. **DON'T CONFUSE THIS NEW ACHIEVEMENT IN INSULATING CASTABLE REFRACTORIES WITH GENERALLY OBTAINED CASTABLES FOR USE TO ONLY 1800° TO 2200° F.** Kast-O-Lite has a fireclay base—a high P. C. E.—and like no other insulating castable, will withstand continued direct exposure to furnace gases to 2500°F.

**KAST-O-LITE combines insulating properties and light weight with strength in one dependable, easy-to-use, castable refractory.**

Now, for dozens of industrial and boiler furnace uses, you can have all the advantages of an efficient, reliable castable refractory—plus the economy and heat saving benefits of insulating firebrick.

All of these properties are combined in KAST-O-LITE, the most amazing refractory material in engineering history. Used in actual service in every type of installation where an insulating castable is desirable and imposing every possible test—KAST-O-LITE has exceeded every operating requirement.

## Wide Range of Uses

Because KAST-O-LITE is not only a castable—or just an insulation—but a dependable combination of both—it offers a wide range of uses. Wherever insulating refractory properties are desired, KAST-O-LITE offers construction advantages and economy. For complete linings, walls, arches or special shapes.

## Easy to Use

KAST-O-LITE, as its name implies, may be cast into place using simple formwork in much the same manner as structural concrete. Mix with water and puddle or pour. Furnace walls, arches, linings or back-up are placed in monolithic sections. Shapes can be made easily and quickly.

## Quick Delivery—Local Stocks & Service

*Warehouse stocks of KAST-O-LITE are located near you for prompt delivery. Look in the classified section of your local telephone directory for the name of your nearest A. P. Green representative. He'll be glad to show you more about the advantages of KAST-O-LITE.*

U. S. MARITIME "M" FOR PRODUCTION ACHIEVEMENT

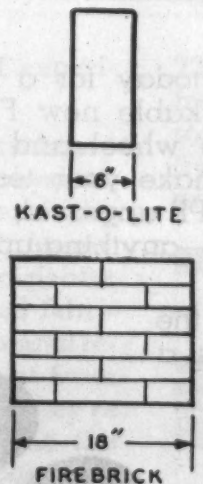
**A. P. GREEN FIREBRICK COMPANY**

A.P. GREEN FIRE BRICK COMPANY — *the First Name in Refractories*

MEXICO, MISSOURI

## Cuts Fuel Bills!

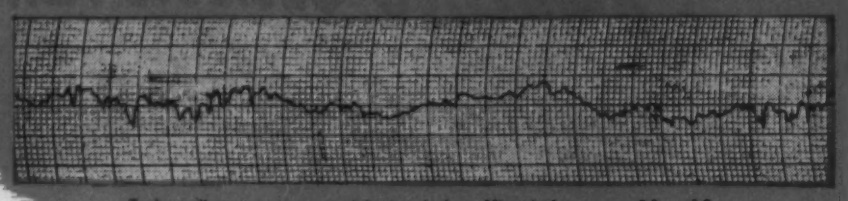
**SAVES—REDUCES HEAT LOSSES**




**The light weight and composition of KAST-O-LITE means that less heat is lost through the lining. Thermal conductivity as used is only approximately 30% that of heavy firebrick. This denotes only 6" of KAST-O-LITE is equal to 18" of firebrick in insulating value. Closer temperature control is possible. Fuel savings result.**

**And because KAST-O-LITE weighs only 78 lbs. per cubic foot the weight of the lining can be reduced approximately 50% as compared with heavy firebrick.**

# Proof of a Better Finish



Each small square represents 1.0 micro inches. Micro inch r.m.s. = 0.9 — 1.8.

## Surface Analyzer Tape Proves You Get a Better Finish With Chicago Wheels

These results were obtained at a rate of 10 pieces per hour in an aircraft parts plant. Material, X-13-15, Rockwell 60 to 57, grinds out .006 to .007 stock. Chicago Wheel used, ½ x ½ x ⅛", Grain 180, Grade L Arcite FV Bond. Spindle Speed 40,000 r.p.m. Lapping and super finishing eliminated on this job.

Can you match that finish? Sounds phenomenal, but you can do it with Chicago Wheels. And, the secret of their superiority lies in the new FV Bond, developed exclusively for Chicago Wheels, after 50 years' experience making wheels for the most accurate and precise applications.

**Here's What FV Bond Will Do for You**

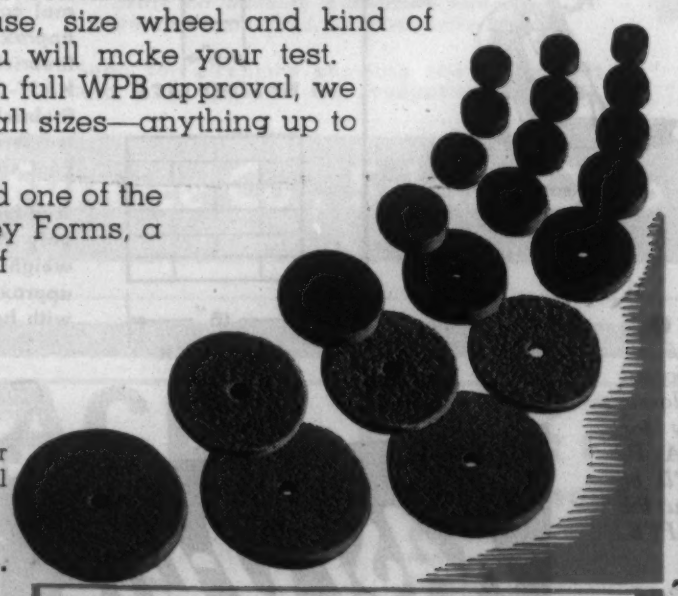
* Reduce your wheel costs
* Produce a better finish without sacrifice of production time—a finish so smooth that you can measure it in micro inches.

TRIAL WHEEL FREE

Write or send the coupon today for a Chicago Wheel, made with this remarkable new FV Bond. Tell us grinder you use, size wheel and kind of material on which you will make your test.

For the duration, with full WPB approval, we are specializing on small sizes—anything up to 3" in diameter.

Write for Catalog and one of the new Engineering Survey Forms, a step in the direction of better finishing.



**CHICAGO WHEEL & MFG. CO.**

America's Headquarters for Mounted Wheels and Small Grinding Wheels.

1101 W. Monroe St., Dept. ME. Chicago 7, Ill.

Half a Century of Specialization has Established our Reputation as the Small Wheel People of the Industry.

ME-6

Send Catalog and Survey Form. Interested in
( ) Mounted Wheels. ( ) Grinding Wheels.
( ) Send Test Wheel. Size.....

Name.....

Address.....

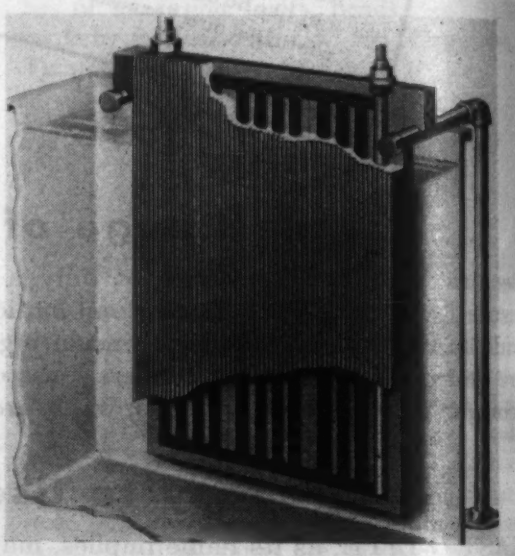

● Four recent additions to its line of "Perfection" welding electrodes are announced by *Anthony Carlin Co.*, 2717 E. 75th St., Cleveland. Grade P-61 is a shielded arc, general purpose, straight polarity d.c. electrode for mild steel. P-103 is a shielded arc a.c. rod for all position welding, suitable for low-alloy high-strength steels. P-170 and P-180 are bare and wash coated electrodes, straight polarity and with a broad field of application.

## Heat Exchanger Made of Graphite

A new type of heat exchanger, called "Karbate," for use in pickling tanks and other metallurgical applications, has been developed by the *National Carbon Co., Inc.*, 30 E. 42nd St., New York 17.

The material in the exchanger is an impregnated graphite impervious to liquids under high pressures. It possesses high heat transfer values, and resists most acids, alkalis and solvents.

The exchangers are of plate type, using



corrugated surface to attain maximum heat transfer area without bulkiness. The company turns out four standard design groups incorporating both parallel and series flow channels, thus making possible 30 different combinations for wide range heating and cooling.

They can well displace steam spargers, which introduce steam directly into the bath itself, thereby diluting the acid.

The major features of these exchangers are their corrosion resistance and mechanical strength.

● The "Tempilscale" for weld bend testing is a pad containing 25 sheets, 3 x 6 in., with one edge carefully ruled in 1/50 of an in., making it possible to measure up to 3 in. to the nearest 1/100 of an in. It is easier to use than flexible steel rules and is more readily applied to sharply curved surfaces. The back carries figures giving the required elongation for every case. It can be obtained gratis from *Tempil Corp.*, 132 W. 22nd St., New York 11.

# JEWELS OF STEEL..PERFECT WITHIN 1/200,000"

One two hundred thousandth of an inch! That's microscopic measurement. But that's how near these lustrous steel balls for frictionless bearings approach absolute roundness.

They are such perfect spheres that the average super-precision gauge can detect no error. They, and the races in which they are assembled, are absolutely uniform in size and hardness.

They're made—millions of them a year—forged, rough and finish ground, hardened, tempered and polished, from Republic Electric Furnace Steel. Because, as one manufacturer put it: "The steel from which these balls are made must be *the cleanest, most highly refined metal that can be produced.*"

Manufacturers of precision products need the added insurance against rejection at final inspection and subsequent loss of material, man-hours and money provided by Republic Electric Furnace Steels. They're as CLEAN and SOUND as the most expert furnace practice and decades of experience can make them.

Republic Electric Furnace Steels are consistently UNIFORM—in physical, chemical, workability, hardenability and performance values. Their homogeneity—their freedom from variables which might upset established fabricating practices—permits manufacturers to derive greatest benefits from mass production methods. They're "targeted" in melting to hit the most rigid specifications—repeatedly.

The unequalled experience acquired by Republic as the leader in this field together with its war-increased capacity are at your disposal to help you produce products *that sell—at a profit.*

**REPUBLIC STEEL CORPORATION**
*Alloy Steel Division*
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**GENERAL OFFICES • CLEVELAND 1, OHIO**
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Niles Steel Products Division • Steel and Tubes Division
Union Drawn Steel Division • Truscon Steel Company
Export Department: Chrysler Building, New York 17, N.Y.

**REPUBLIC**
*—Leader in the Production of*
**ELECTRIC FURNACE STEELS**
**"QUALITY" steels . . . alloy . . . stainless**

# ARMOUR'S ANHYDROUS AMMONIA

*For Nitriding and Protective Atmospheres*

*Guaranteed Pure, Dry*

**Over fifty years of experience in servicing thousands of ammonia users assures you that when you order Armour's Anhydrous Ammonia, you get not only a pure, dry, dependable product, but also the best service available.**

**Take advantage of our technical service by writing us on any problems concerning the use of Anhydrous Ammonia in Nitriding, Dry Cyaniding, or as a protective atmosphere either by itself or in conjuction with other gases.**

**Prompt delivery in Bottle Type or Tube Type cylinders, 100 lb. and 150 lb. sizes, from one of our plants or nearest of our sixty stock points.**

## ARMOUR AMMONIA WORKS

DIVISION OF ARMOUR AND COMPANY

1355 West 31st Street, Chicago, Illinois

***For free descriptive circular on the proper method of handling and hooking up Anhydrous Ammonia cylinders, please clip and mail the coupon below.***

Armour Ammonia Works,
1355 W. 31st St.,
Chicago, Ill.

Please send by return mail a copy of your circular on "Methods of Handling Cylinder Anhydrous Ammonia for Metal Treaters."

Name.....

Title.....

Company.....

Street.....

City.....State.....


## Seam Welding Control

A new control designed exclusively for seam welding, incorporating a completely electronic timing circuit, is announced by the *Industrial Control Div., General Electric Co.*

Designated as Type CR7503-B110, the control is especially suitable for operations where frequent changes of the timing pattern are required, such as when welding a variety of materials of various shapes and thicknesses.

Operating on a 230/460/575-v., single-phase, 60-cycle power supply, the control consists of a timing panel, a firing and heat control panel, and a power panel, any one of which can be separately disconnected and removed to facilitate inspection or servicing.

An electronic circuit, incorporated in the control, provides accuracy of the timing pattern of the weld without utilizing moving parts and regardless of normal, instantaneous, or gradual line-voltage variation. Smooth heat control is provided by the phase-shift method.

● Where it is necessary to watch an operation or dial at a point otherwise not visible, magnifying mirrors have been devised by *Larrimore Sales Co.*, P. O. Box 1234, St. Louis 1, Mo. The mirrors are focused upon the object, usually 10 to 12 in. distant. The glass mirror proper, 5⅞ in. in diam., is atop a 15 in. bracket in the form of a tube.

## Versatile Abrasive Wheel Dresser

A universal grinder that allows a limited experience operator to dress abrasive wheels accurately to any contour is announced by *Best Tools Corp.*, Rockville Centre, Long Island, N. Y. It is called the Universal radius, angle and contour dresser.

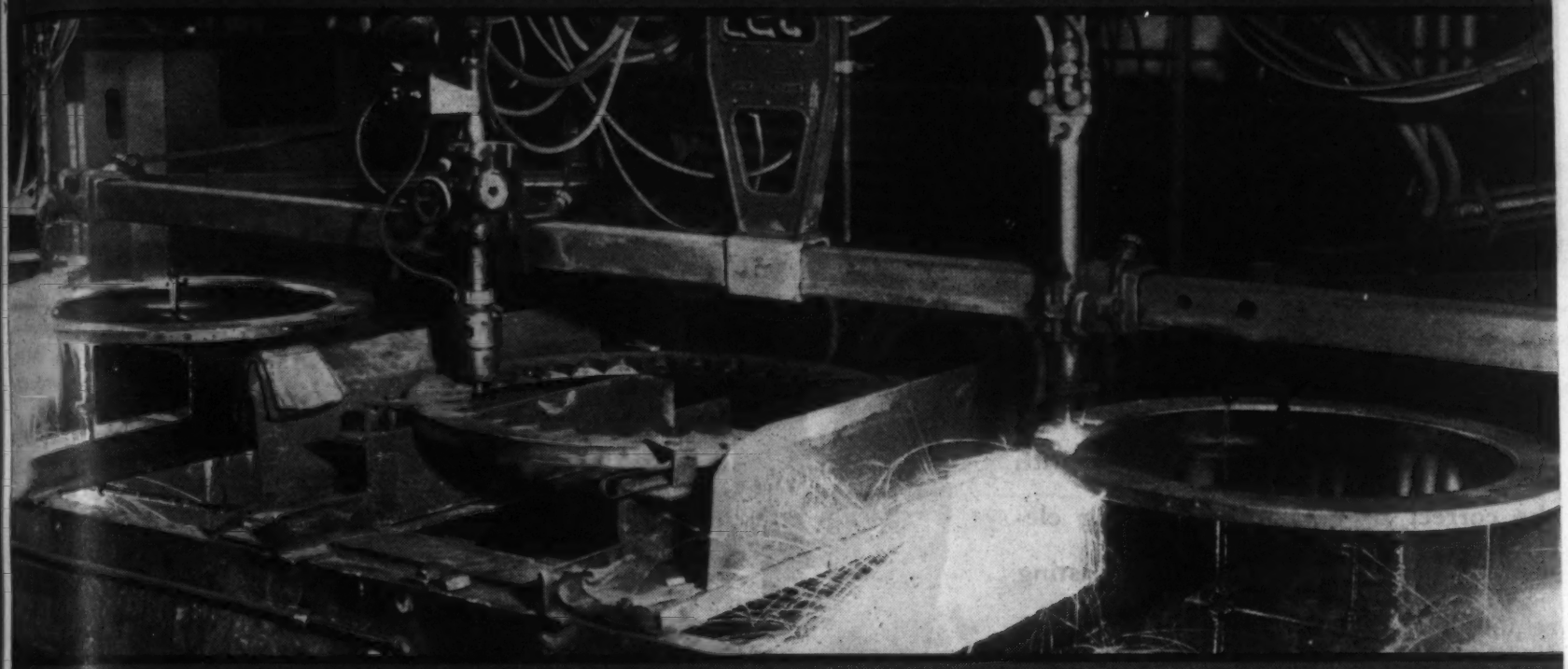
Contour dressing is done by placing a steel template of the desired contour on the base held in place with a clamp. The base is then placed against the gage on back of the magnetic chuck of the surface grinder. The head is lowered into position, and a spring activated tracer point comes in contact with the template.

As the operator turns a knurled knob, the tractor point follows the contour of the template and, in turn, the chisel pointed diamond generates the same contour on the abrasive wheel.

By the proper transposition of the various attachments to the sliding head casting, a great many hitherto unobtainable shapes can be obtained quickly and duplicated easily.

● A new wire, "Silvercote," of "spring grade" beryllium copper is now marketed by *Little Falls Alloys, Inc.*, 189 Caldwell Ave., Paterson, N. J., and is available in sizes 0.064 to 0.007 in. It has a guaranteed minimum tensile strength of 185,000 lb. after hardening.

# Special Equipment, Experience and Quantity Production



## make C-W Flame Cut GEARS and BLANKS economical

**For years, this company has been manufacturing flame cut gears and gear blanks in quantity. This type of production is perfect for our specially developed machines and years of experience. As the bars of steel travel through the rolling, welding, forming, sizing and heat treating machines, each step is conducted with scientific accuracy born of experience. Our own metallurgists and engineers watch every operation. Quantity production is obtained through highly specialized machinery, such as the template torch cutting process shown above. Our methods were developed to insure economy on welded products.**

**If you are in need of gears or gear blanks, let us talk to you now while you are doing your postwar planning. In addition to gears and gear blanks, we also make all types of circular, rolled and welded steel products... whether they be rings, bands or hoops, and regardless of specifications. We suggest that you contact us NOW!**

*the* Cleveland
WELDING COMPANY
WEST 117th STREET at BEREA ROAD • CLEVELAND, OHIO

DURALOY

HIGH ALLOY CASTINGS

FOR MORE than twenty years Duraloy Metallurgists and Foundrymen have been producing castings with the correct proportion of alloying elements. Because each High Alloy Casting requirement presents its own problems and requires special consideration, the importance of experience is self-evident.

Let Duraloy take care of your next chrome-iron or chrome-nickel castings. They will be alloyed by Metallurgists who understand process plant requirements and poured by Foundrymen who know how to handle high alloy castings . . . an art in itself.

THE DURALOY COMPANY

Office and Plant: Scottdale, Pa.

Eastern Office: 12 East 41st St., New York 17, N. Y.

Los Angeles & San Francisco: Kilsby & Graham

Chicago & Detroit: F. B. Cornell & Associates

Scranton, Pa.: Coffin & Smith

Metal Goods Corp.; St. Louis—Houston—Dallas—Tulsa—New Orleans—Kansas City

6-DU-1


● A new method for anodizing zinc to increase corrosion resistance is announced by *United Chromium, Inc.*, called "Anozinc." It is applicable to zinc plated on any metal, and in some cases to zinc-base die castings. Parts finished in Anozinc baths have stood up in excess of 200 hrs. under the Army-Navy salt spray test, AN-QQ-S-91. There are two finishes: dark, semi-lustrous black, and a brassy, iridescent yellow.

## Precision Gage Instruments

Twenty special instruments to use with gage blocks, sold separately, or together, are announced by *Continental Machines, Inc.*, 1301 Washington Ave., South, Minneapolis. They fill the demand for a broader application of gage blocks.

In combination with the blocks, they will perform practically all precision measuring functions. Thus, with the gage holders and caliper bars, any type of "Go" or "No Go" snap gage can be made up in seconds, accurate to millionths of an inch.

They can make a precision height gage, 1000 times more accurate than a standard height gage.

Trammel points and center points for checking layouts, scribing arcs or parallel lines, checking center distances or the lead of a thread, are included in the set. Two quartz optical flats and a high intensity monochromatic light show by dark bands the exact contour of the work.

All instruments, like the blocks, have been stabilized by the new treatment at minus 120 F., assuring that they hold their accuracy.

● Magnafluxed parts, cleaned with "Cyclodiene," are ready for surface finishing, such as rust proofing, painting and electro-plating. Made by *Technical Process Div., Colonial Alloys Co.*, Colonial Philadelphia Bldg., Philadelphia 34, a simple dip or spraying of this hydrocarbon solvent removes the oil and dye. Toxicity is negligible, and it tests neutral as to acidity. Solutions may be used over and over again.

S. A. E. 4150 steel before carbon correction. Decarburized to depth of .003". White areas below black background show loss of carbon, leaving a surface of soft iron only. This part of the metal is no longer steel.

Same steel after carbon correction. Note entire absence of decarburized areas and the uniformity of carbon content throughout the cross section.

***...This striking change from bad to good steel is made possible by a revolutionary process developed by the makers of Lithium Atmosphere Furnaces...***

When steel leaves the mill, the surface is decarburized . . . surface carbon is lost when the steel is heated for the rolling and fabrication processes. This loss of carbon lowers the fatigue value from 40% to 50% and greatly reduces the tensile strength of the part.

Steel makers and steel users know these facts . . . have been compelled to accept them because they could not put the lost carbon back into the surface.

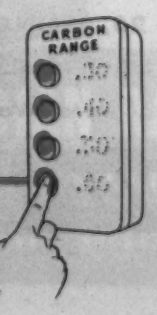
All this is now changed by LITHCARB Carbon Correction—a simple process of interest to all who make or fabricate steel. Decarburized steel treated in the Lithium Carbon Correction Furnace comes out bright, clean and with its surface carbon fully restored.

The process is based on the use of Lithium metallic vapor which chemically reacts continuously with the furnace gases throughout the entire process to eliminate completely *in the muffle* at the work, every trace of oxygen and water vapor. This makes it unnecessary to maintain critical equilibria in the atmosphere.

Control, therefore, is positive, automatic, unfailing. For example: if you wish to replace carbon in 1040 steel, you merely push a button marked ".40% carbon." This causes the carbon to be restored exactly to S.A.E. .40% throughout the full decarburized depth and at a rapid rate. Control can be set for other desired carbon replacement ranges.

LITHCARB Selective Carbon Correction is only one of three processes based on the proven Lithium vapor principle. The others are LITHCO for Neutral Heat Treating and LITHCARB for Bright Carburizing. The use of Lithium vapor and its control of the atmosphere at the work is exclusive with The Lithium Co.

**LITHCARB**
SELECTIVE
**CARBON CORRECTION**
*..It starts where steel making stops*




**THE LITHIUM COMPANY**
Manufacturers of Atmosphere Furnaces
111 SYLVAN AVENUE, NEWARK 4, NEW JERSEY

• No "magic wands" or "cure-alls" are at the command of the Stuart service engineer. For a wand he uses the fund of engineering experience developed by D. A. Stuart Oil Co. over 79 years in the business. Instead of cure-alls, he offers top quality cutting fluids engineered to job requirements. With these simple tools he has achieved results in metal-working far more useful than the best that magic can boast. With your cooperation, we feel confident that he can do the same for you.

Our free booklet called "The 577th Oil" gets down to cases. Write for your copy.

## Elliptical Infra-Red Oven

Heat from the lamp filaments "billiard" against the highly reflective interior insulated wall to the heat zone located along the opposite side of the oven in the new "Hy-Heat Elliptical Oven," put out by *Infra-Red Engineers & Designers,* 1633 E. Fortieth St., Cleveland.

All the heat rays are concentrated in an imaginary "pipe" or heat zone about 2 in. in diam. Operation is based on the theory of an ellipse that has two centers or foci. The lamps are placed in one of these and the work in the other.

The inside size of the standard unit is 9 by 12 in. and 250-w. lamps are used. The oven is designed in two halves that may be separated to admit, for example, a continuous wire or cable requiring a repair. Temperature range possible is 70 to 400 F.

In the wire and cable industry, products may be processed to bake on various coatings automatically as the production passes rapidly through the heat zone. Stress relief and heat treatments automatically applied are possible in die casting.

● A new group of five metal cleaners has been made available to metal products manufacturers and electroplaters by the *Hanson-Van Winkle-Munning Co.,* Matawan, N. J. Designated as NL cleaners, they are for cleaning by soaking or in washing machines. Each cleaner is prepared in two forms, one suitable in still tanks and the other in power washers and tumbling barrels.

## Sand Mullor for Foundries

A new portable sand mullor, the Mulbaro, will be of particular advantage to small foundries for preparing sand because initial price is low and maintenance costs almost nil.

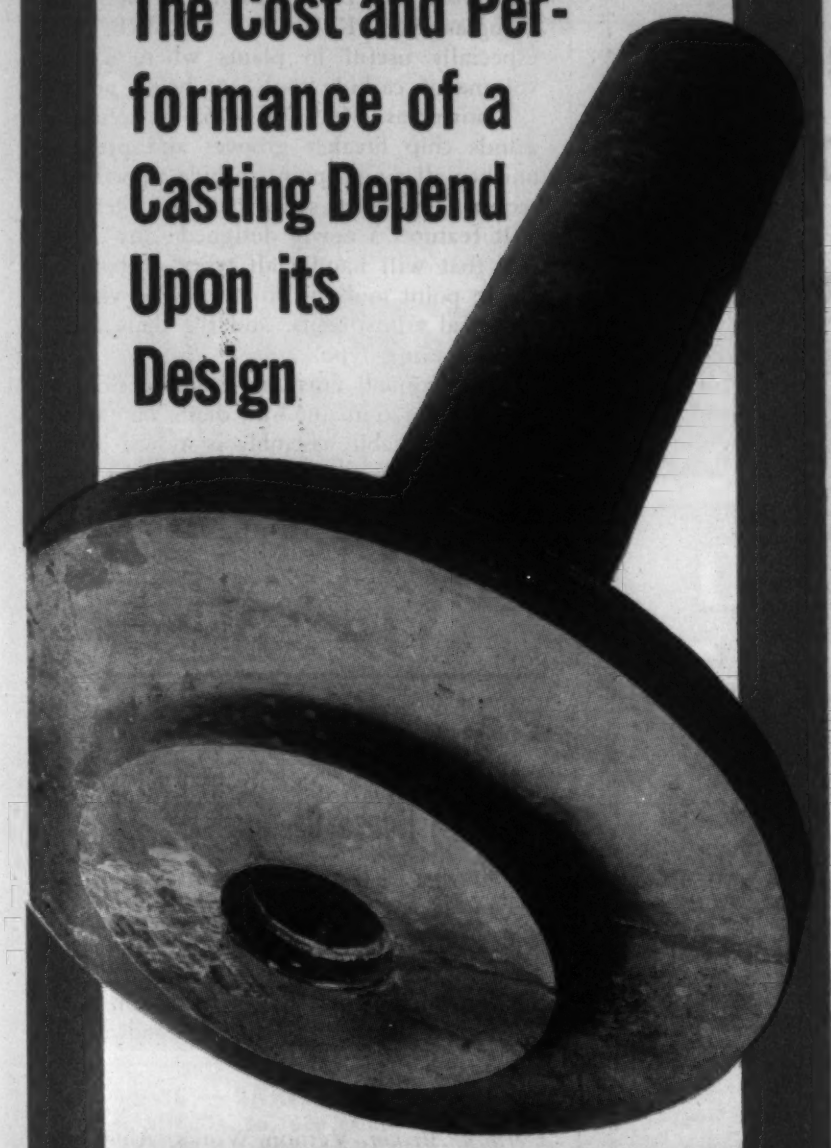
Made by the *Beardsley & Piper Co.,* 2541 N. Keeler Ave., Chicago 39, the mulling action is done by rubber-covered rolls, designed to the contour of the mulling bowl at such an angle as to conform to the curve of the bowl, eliminating any tendency of the wheels to crush the sand.

The mullors knead and squeeze the sand, and the plow action does thorough aerating. The combination of these assures maximum benefits from additions and a thoroughly mixed batch.

Handling of a great variety and mixes of sand without contamination of one batch with another is possible. It eliminates much cleaning and keeps the floor free from sand piles.

● "Fix-Iron" for repairing broken, cracked or defective metal castings, piping, etc.; for making joints, seams and loose parts secure; and for stopping leaks in boilers, furnaces, fire pots and other metal equipment, is announced by *So-Lo Works,* Loveland, Ohio. It is in powder form, and is mixed with water preparatory to use. No heat is needed and it hardens rapidly like iron.

# The Cost and Performance of a Casting Depend Upon its Design



Improperly designed castings increase production costs and often result in service failures. To avoid this danger, why not contact our engineering department to insure a better and less expensive job on your next casting? Our technicians are familiar with the *practical* principles of good casting design, and by sitting in on the planning of your casting we'll be able to recommend minor changes in design that mean major changes in the final cost. Correct design permits full use of the advantages available in the superior engineering properties of ABSCO MEEHANITE* Losses due to machining defective castings are reduced with ABSCO MEEHANITE. Produced under strict metal control and supervision it insures continual uniformity and soundness of structure. The easy-machining qualities of ABSCO MEEHANITE also represent a further saving.

Try this combination of design advice and ABSCO MEEHANITE – the next time a casting problem arises.

*Bridging the gap between steel and cast iron ABSCO MEEHANITE combines the best properties of these two metals. It is available in 21 different types under 4 classifications: General Engineering—Heat Resisting – Wear Resisting – Corrosion Resisting. Send for Meehanite Engineering Handbook.

H58

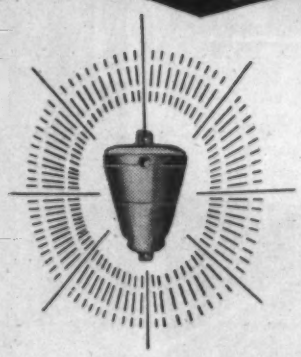
BRAKE SHOE & CASTING DIVISION

AMERICAN Brake Shoe COMPANY

230 PARK AVENUE, NEW YORK 17, N. Y.



CANADIAN RADIUM IN MODERN INDUSTRY



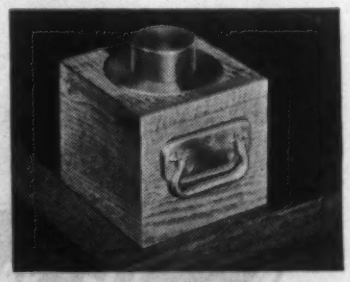
## CANADIAN RADIUM provides all-around sectional records in a single exposure

Examining shell casings, shafting, pressure vessels and similar enclosed metal parts to detect internal flaws and determine soundness, is an easy matter with a capsule of Canadian radium only an inch in diameter.

In many cases, radium radiography is the only method of locating and identifying internal defects in castings and welds. If sound quality is important in parts you make or use, Canadian radium will save you time, money, materials.

**COMPACT! PORTABLE!**

A radium capsule in its handy carrying case and a supply of film, comprises all the equipment for making radiographic examinations of metal sections—thick or thin—on your own premises or elsewhere.



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Reliable, profusely illustrated 80-page textbook on the fundamentals and technique of modern Industrial Radiography of Metals with Radium. Specially prepared for the metals industry by our research and technical staff. Write for your copy today, giving your name and company position.

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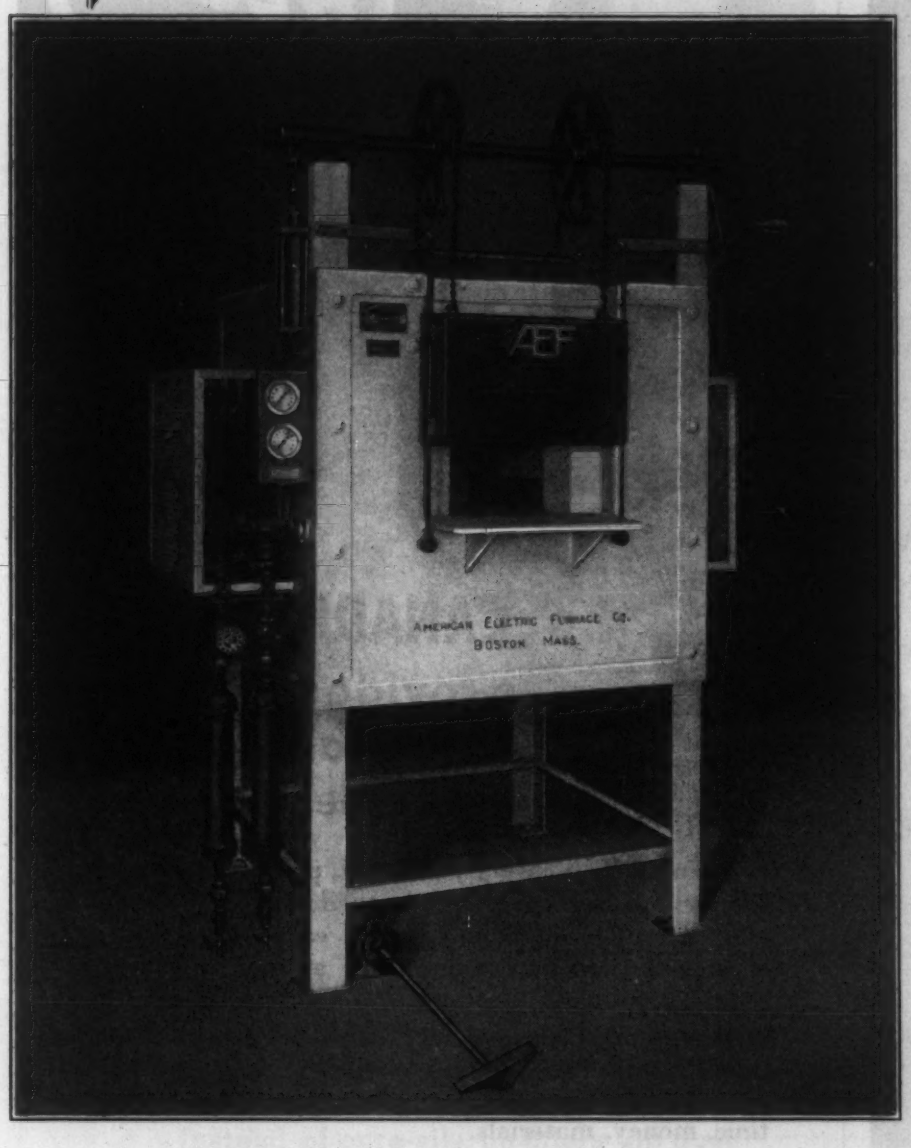
"AMERICAN"
High Speed Furnaces
for the better steels of tomorrow




Model HB1218 High Speed Furnace
with synchronized atmospheric control.

ARMY E NAVY

For simplified heat treatment
of high speed steels use
"AMERICAN" atmospheric control.

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29 Von Hillern St. Boston, Mass., U. S. A.
Industrial Furnaces for All Purposes


## Chip Breaker and Finishing Grinder

A new, heavy-duty chip breaker and diamond finishing grinder is announced by *Hammond Machinery Builders, Inc.*, 1646 Douglas Ave., Kalamazoo 54, Mich. It is especially useful in plants where a large volume of carbide tools are being ground.

Known as Model CB-76, it accurately grinds chip breaker grooves and precision finishes all single point carbide tipped tools requiring smooth, sharp cutting edges.

It features a newly designed "any" angle vise that will handle all types of box and single point tools up to 2 in. The vise has universal adjustments, and the dials are of direct-reading type.

The diamond finishing grinding side can use either a 6-in. or 7-in. diam. cup wheel. The tilting table assembly is moved in and out by screw adjustment rather than slid by hand.

## House Organ Notes

*Continental Victory Bulletin*, Continental Foundry & Machine Co., May 5, 1944.

In the South Pacific the Navy's Seabees are finding the M-4 Sherman tank an ideal road-building tool. Its 75-mm. gun saves time and expense in blasting a roadway out of volcanic rock.

*Vernon Alcoan*, Vernon Works, Aluminum Co. of America, May 8, 1944.

"Aluminum is cheaper now and better than most other metals. It can be shaped economically by every known method—it has no equal in this respect. It can be melted and poured into molds—it can be rolled hot or cold—it can be made into thick, tough strong plates. It can be made into flexible sheets and into foil."

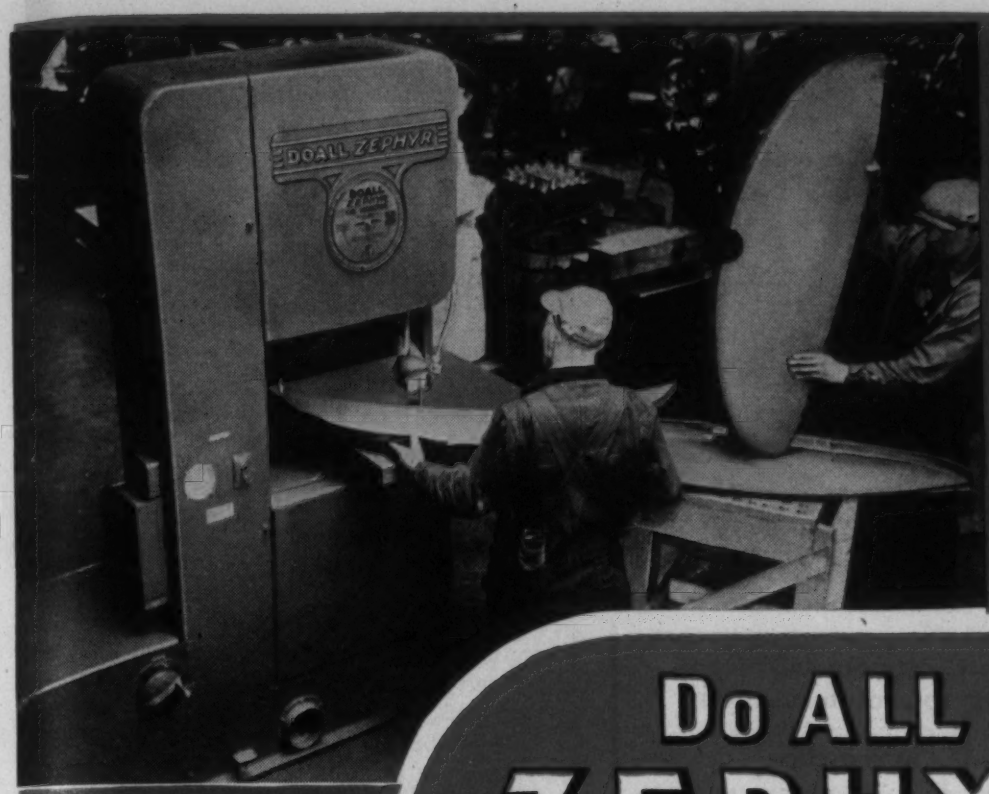
*Lukens Life*, Lukens Steel Co. and Affiliates, Vol. 6, No. 1.

"A new era in expansion joints for highway bridges was inaugurated with the advent of the sliding finger-type of joint, flame-cut from steel plate, 3 in. thick. Joints are entirely jolt-free and noiseless, being set flush with the concrete surface of the road. Fingers are so close to each other laterally and of such dimensions that wheels of vehicles are at no time without adequate support. They resist wear and impact, and retain their perfect alignment."

*Aluminum Progress*, Reynolds Metals Co., April, 1944.

Here is another new house organ, Vol. 1, No. 1. We glean the following interesting bit: "In 1821 P. Berthier discovered that a non-plastic, clay-like substance from Les Baux, near Arles, France, was low in silica

(*Continued on page 1584*)



*ALUMINUM*—Extruded bars. 75.2 square inches per minute cut on the Zephyr.

*MAGNESIUM*—10" thick. Zephyr cuts 120 square inches per minute.

*WOOD*—ROCK MAPLE, 380 sq. in. per min. MAHOGANY 432 sq. in. per min. PREGWOOD, 1⅜" thick, 76 sq. in. per min.

# Do ALL ZEPHYR

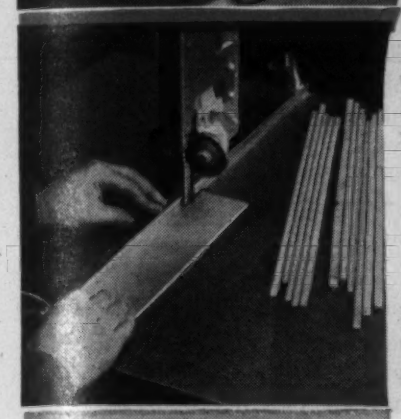
## *Cutting Speed up to 10,000 F.P.M.*

**Has cutting and shaping the new light alloys stumped you and your present band saw?**

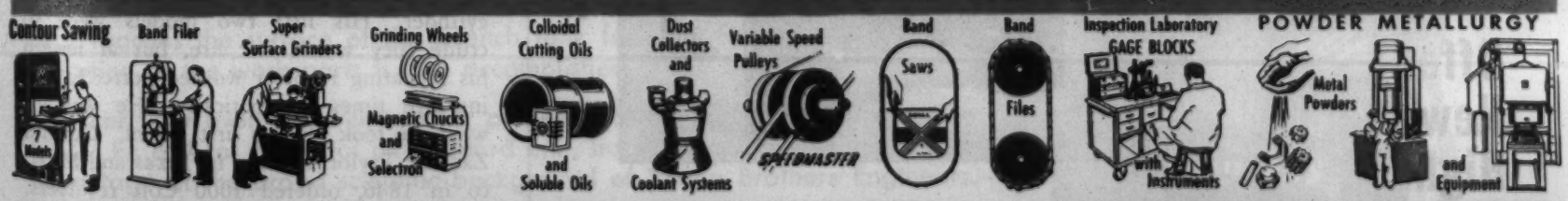
**Don't worry—the new DoALL Zephyr was developed especially for these lightweight metals, also for plastics, laminates, plymetals, alloys, wood, etc.**

**Here's safe, smooth speed up to two miles a minute, supported in a Gibraltar-like housing of welded steel. Equipped with Speedmaster and Job Selector, for quick selection of proper saw and speed for each new job.**

***Send for interesting illustrated Zephyr Circular today.***



**PLASTICS — BAKELITE ¼" thick, 106 lin. in. per min. SPAULDITE ¼" thick, 82 lin. in. per min. INSUROK (below) 16 sq. in. per min.**




# DoALL

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IF THERE IS A FLAW "FLASH-O-LENS" WILL FIND IT!

The new FLASH-O-LENS offers foundry-men, machinists, and many others engaged in producing metal parts for war contracts an efficient, economical means of examining the most minute defects during routine inspections.

FLASH-O-LENS consists of a portable 40x microscope combined with a perfect source of illumination in one convenient, compact unit . . . They are available in several models—powered by either standard flash light dry cells or by current from any AC or DC outlet—and with a selection of various combinations of lenses, all interchangeable in the one lens housing.

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Offer New High Temperatures For laboratory use where materials are to be heated in an oxidizing atmosphere to temperatures from 1500° to 2750°F. Provides rapid heating, also heating in special atmospheres not injurious to silicon carbide. Write for data.

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Incorporated 1924


content—either free or in combination. Analysis indicated 52% alumina, 27.6% ferric oxide. He called it 'le mineral des Beaux' (the beautiful mineral). Later Dufrenoy coined the word, 'Bauxite'. In 1861 H. St. Clair Deville, father of the aluminum industry, changed spelling to 'Bauxite' to correspond to the place of its discovery, Les Baux."

*Nassau,* Nassau Smelting & Refining Co., April, 1944.

"Every time they scrape the bottom of the Delaware River to make way for current wartime traffic, U. S. Army engineers turn up leftovers of the nation's first defenses against invasion. One obstruction, called 'chevaux-de-frise', was anchored on the river bottom to keep the British fleet from Philadelphia. Another type of submerged fortification, the 'stockadoe' has been dug up recently off Hog Island. It consists of huge stringers, 40 ft. long and 2 ft. square, crossed by 20-ft. timbers to form a crib, floated to position, filled with stones and sunk. Eighty-foot beams tipped with sharp-pointed spearheads weighed 100 lb. each and were placed in the crib at an angle, points directed dangerously downstream. In 1778 they were declared the 'rebel' secret weapon. But a traitor gave away the position, one story insisting that the traitor was the man who installed them."

*Bristol Recorder,* Bristol Co., April, 1944.

Under the heading, "Take Your Pick": "A majority can never replace a man. A majority always represents both stupidity and cowardice. There is no principle so wrong as the parliamentary principle.—Adolf Hitler in *Mein Kampf.*

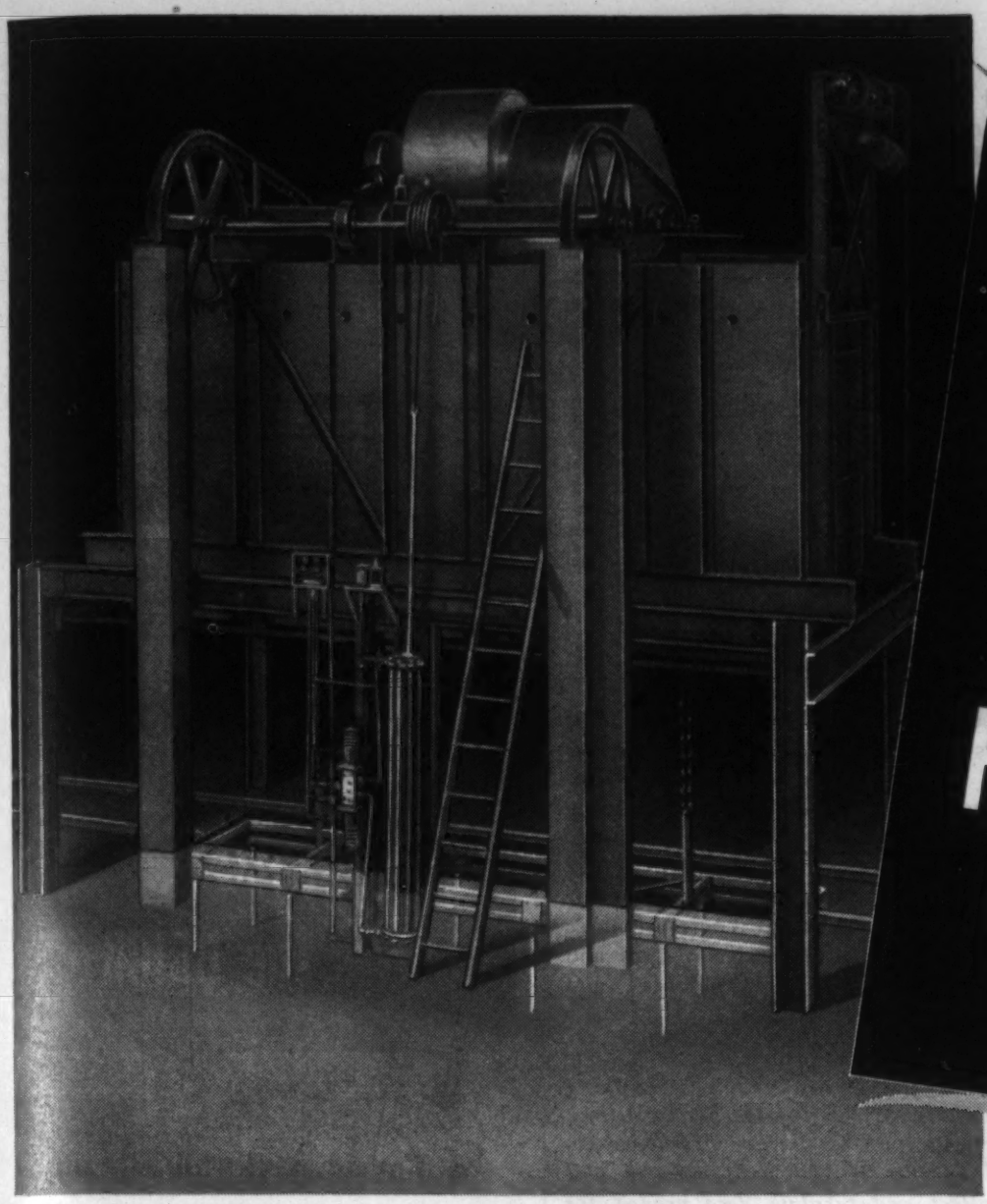
"No man is good enough to govern another without the other's consent".—Abraham Lincoln.

*Gung Ho,* Editorial Research, Inc., Vol. 1, No. 1.

Even as a small boy, Samuel Colt had a passion for guns, and was sure that some day he would invent a gun that would fire without reloading. Once he tied four gun barrels together with a wire, but instead of firing one shot at a time all went off together. On a trip to India he observed that no matter which way the steersman turned the wheel each spoke came directly in line, and a notched clutch held it fast. This was his clue for a gun with a revolving loaded cylinder. His first two models were so crude they would not fire, but at length his repeating revolver worked perfectly, firing five times automatically. He was 22 when he took out his first patent. General Zachary Taylor, fighting in Texas and Mexico in 1846, ordered 1000 Colt revolvers. He subcontracted various parts so that no one manufacturer would learn the secrets of the complete gun. Eventually the wild and woolly West was tamed by the Colt revolver.

*The Carbuilder,* Pullman-Standard Car Mfg. Co., March, 1944.

"Is welding a new art? Iron was welded to bronze in 800 B.C. The ancients, having found out how to produce heat that would



# How Oven Engineers Tackle a Heat Treat Problem

***THE PROBLEM***—Heat treat aluminum alloy aircraft parts of various sections and lengths in production batches. "Soak heat" at 960° F. with a maximum permissible oven temperature variation of 5° F. throughout the load space. Water quench the charge within 4 seconds after leaving the oven atmosphere.

***SOLVED***—by Young Brothers Engineers, the bottom loading oven illustrated was the result. This is an electrically heated unit with a work space 3'6" wide, 16'3" long and 5'6" high, loaded by a car running on rails which straddle the quench tank not shown in the photograph.

The work is protected from direct heater radiation. Large volume recirculation and a dual temperature control system assures uniform temperature distribution and close regulation.

Operating sequences are electrically interlocked. The closing of a single switch when the load is ready for quenching, automatically disconnects the heaters and fan motor, opens bottom doors and drops load cage rapidly toward the surface of the quench tank. As the load cage clears, the doors automatically close to conserve heat. Checking of the speed of the load cage as it reaches the surface of the quench tank for slow immersion to reduce distortion of the work parts is also accomplished automatically.

Whether your oven requirements for processes involving temperatures up to 1000° F., call for a special or standard unit, batch or continuous type, take advantage of the broad scientific background of Young Brothers Engineers.

Ask for our new Bulletin covering Heat Treating Ovens.

IF YOU HAVE HEAT TREAT PROBLEMS *Consult* YOUNG BROTHERS ENGINEERS

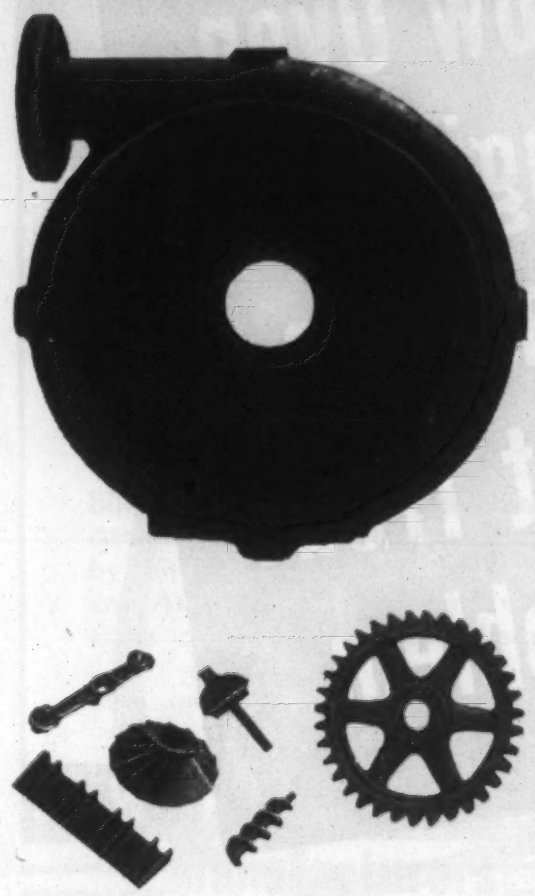
**YOUNG BROTHERS COMPANY**

**6514 MACK AVENUE • DETROIT 7, MICHIGAN**

YB CO

**STAINLESS STEEL CASTINGS**

***Resistant to Acid Corrosion and Heat***



In the manufacture of Stainless Steel Castings it is important to know how! Atlas metallurgists have been specializing in the casting of corrosion resistant alloys for over 20 years, and have pioneered many of the revolutionary methods used today for casting corrosion resisting alloys. Every Atlas Stainless Steel casting is designed purposely for the particular job. Atlas foundrymen do know how! Your inquiries are invited.

Write for illustrated bulletin.

**ATLAS**
**STAINLESS STEEL CASTINGS**

Division Atlas Foundry Co.
520 LYONS AVE. IRVINGTON, N. J.


extract metallic iron from rich ores, considered all iron as precious metal. The 800 B.C. bronze ball with its iron shaft undoubtedly was made as a piece of jewelry or decoration, and the two metals were joined by applying heat and pressure. Later, in suits of armor, rivets were used only for pivots, but welding was employed to fasten the hardened breast plate to the softer metal of the suit. It was probably a laborious process of heating and pounding."

## Briefs on Associations, Promotions, Education

A new standing committee, B-9, on metal powders and their products has been organized by the American Society for Testing Materials. Technical men, representing producers and users, are on the committee and its sub-groups, with W. A. Reich, Works Laboratory, General Electric Co., Schenectady, N. Y., as chairman. There are three sub-committees on: (1) nomenclature and technical data, (2) metal powders, and (3) their products.

*Comptrollers or auditors of seven steel castings companies to serve as a standing subcommittee on costs of the Steel Castings Industry Advisory Committee have been appointed by the OPA. The committee will help collect and tabulate data needed for the cost study.*

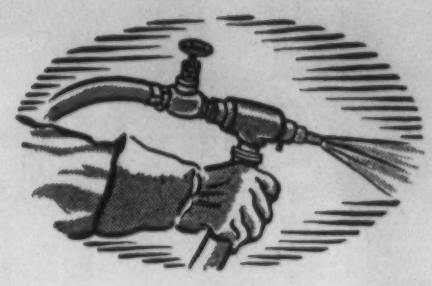
Dr. Willard Henry Dow, president of Dow Chemical Co., has been presented with the Gold Medal award of the American Institute of Chemists for 1944.

*Ten George Westinghouse scholarships, each valued at* $1,850, *have been awarded to top-ranking seniors in high schools from coast to coast. Recipients of the awards were chosen on the basis of mental ability, aptitude for engineering, and qualities of leadership and personality.*

"The cost of finish-machined Diesel engine weldments, in moderate repetitive production, is on the average 330% more expensive than the cost of similar Meehanite castings." So spoke L. F. Williams, market research director, Cooper-Bessemer Corp., before the Meehanite Research Institute of America. "Sufficient weight and service advantages to offset this cost differential have failed to appear."

*Dr. Walter Emil Ludwig Mathesius, president, Geneva Steel Co., has been awarded the Francis J. Clamer medal "for meritorious achievement in the field of metallurgy" by the Franklin Institute. The official citation mentions: "particularly for his contributions in the field of blast furnace practice."*

Vacant spaces in the atoms of nickel are responsible for its resistance to corrosion, Dr. Herbert H. Uhlig, metallurgist, General Electric research laboratory, told the Electrochemical Society recently. The copper atom has one more electron than nickel, and when

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*Protects* The SURFACE
*Saves* The BRICK

**● Forms a Highly-glazed Vitrified, Monolithic Surface**

**A simple application of Brickseal with brush or spray gun, protects your furnace refractories against cracking, spalling and deterioration due to variable temperatures, differential heating, corrosive vapors, and flame abrasion.**

**Furnace is ready for operation immediately after application of Brickseal. Heat of furnace vitrifies Brickseal permanently into all pores, cracks and joints, and forms a highly-glazed, monolithic coating. Brickseal cannot crack, peel or blister due to sudden temperature variations because it remains semi-plastic until furnace cools.**

**Write for sample or Brickseal representative, today.**

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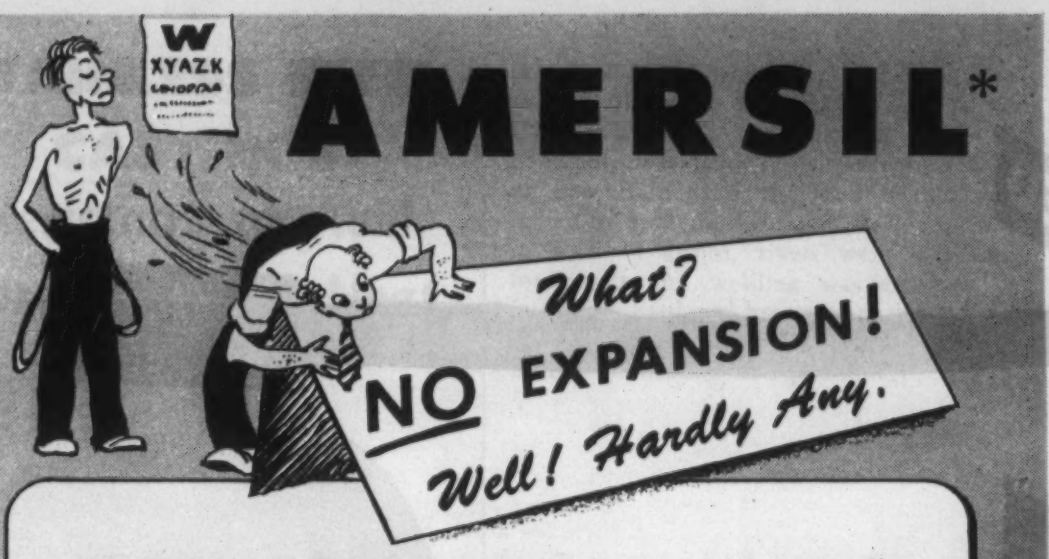
Same type of knife . . . same heating to 1500° F.—then came the quench. See what a drastic water quench did to the cutting edge. Oil here was also too severe. So the manufacturer tried quenching in salt at 400° F. Result: no distortion or warping.

Another example of the place which the salt bath "interrupted" quench is rapidly filling in modern heat treatment!

Houghton supplies an ideal salt for this purpose—MAR-TEMP Salt—which affords a rapid quenching speed through the critical range. It is fluid, easily cleaned from the work, stable, unharmful to the steel. It is low in melting point and in molten viscosity.

For full data on martempering, the newest thing in heat treatment of war-time steels, call in the Houghton Man, or write directly to E. F. HOUGHTON & CO., Philadelphia 33, Penna.

*Salt-quench in Houghton's* **MAR-TEMP**




Amersil's* low coefficient of expansion is one of its outstanding characteristics. It is only 0.000000054. This is 1/34 that of copper, 1/17 that of glass or platinum and 1/9 that of tungsten.

This characteristic of Amersil* chemical and industrial plant equipment—piping, absorbers, cooling sections, etc., permits extreme temperature variations. Operation at temperatures as high as 2100°F. may be maintained regularly, or up to 2700°F. for short periods, and widely varying temperatures may be carried in the same apparatus.

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There's a Correct Solution to

Your Cleaning Problem

You may have one that, thus far, has baffled every effort to find the answer. It might be on cleaning metal surfaces, or concerning plant maintenance, or about a special cleaning process to be used prior to applying certain wartime finishes.

Thousands of problems have come to us during the past 20 years. Very rarely have we failed to conquer the difficulty. In barely a single case has PERMAG Cleaning Compounds met defeat on the job they were assigned to do.

*There's a PERMAG Compound made for every cleaning job. If you have a problem, write us. Our experienced Co-operative Service can help you. No obligation for interviews.*

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More than 340 Cleaning Compounds are now made under the PERMAG trade name to meet the growing demands of industry.


the two are alloyed, the extra copper electrons fill the vacancies in the nickel atom. When 60% Cu and 40% Ni is reached, all the nickel vacancies have been filled. Further increasing the copper makes the alloy less resistant to corrosion.

*A welding news contest has been inaugurated by Hobart Bros. Co., Troy, Ohio, for stories about interesting arc welding jobs. Two hundred dollars in prizes will be awarded each month.*

Because of training of "carbide supervisors," the total estimated amount of machining handled by carbide tools has increased from a few per cent of all metal removal before the war to more than 50% of metal removal in 1944. So stated K. R. Beardslee, vice president, Carboloy Co., Inc., Detroit, before the Machine Shop Practice Panel session of the Chicago War Production Conference.

*Dr. John Fairfield Thompson, executive vice president, International Nickel Co., has been awarded the* 1944 *Egleston medal of the Columbia University Engineering Schools Alumni Association for distinguished engineering achievement.*

For suggesting a winning trade name for steel shot and steel grit, the Western Metal Abrasives Co., Chicago Heights, Ill., will award a $100 war bond.

*Free training "for a better job in war industry" is being given by Manhattan College, School of Engineering, New York* 63. *Night classes for men and women at convenient centers in downtown New York are being conducted. A typical course is called "Fundamentals of Engineering."*

White hot steel, at a temperature as high as 2000 F., and moving at a speed of 20 miles an hr. as it emerges from a rolling mill, can have its thickness accurately measured by X-rays, stated Dr. William D. Coolidge, General Electric vice president in charge of research, in his acceptance of the Franklin medal, awarded by the Franklin Institute, Philadelphia.

## News of Engineers

*Robert S. Archer* has joined the Climax Molybdenum Co. as metallurgical assistant to the president. Since 1934 he has been chief metallurgist, Chicago district, Republic Steel Corp. Past experiences have been with the Aluminum Co. of America and the A. O. Smith Corp. He collaborated with Zay Jeffries in the preparation of the book, "Science of Metals", published in 1924.

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*James F. Reid,* former deputy chief, Alloy Steel branch, WPB, has been appointed production manager, Timken Roller Bearing Co., Canton, Ohio, a position he held prior to going to Washington in May, 1942.

---

*Edgar K. Mull* has been appointed chief metallurgist, Barium Steel Corp., Canton,

**One of a series of articles on the preparation of metal surfaces for protective finishes**

# INFORMATION ON SPECIFIC CLASSES OF PICKLING

**Wire Pickling**

From safety pins and bobby pins to the coiled springs in the easy chairs and the mighty steel cables that sustain suspension bridges — all wire must withstand the stress of bending, coiling and twisting as well as tensile strain.

Not only must the correct analysis for the metal be chosen but the treatment in reducing it to its proper size and form must not impair the quality. The transformation from the steel bar to the tough, slender wire requires expert knowledge and handling.

Pickling of wire, while an important step, is an old practice, and as such, often fails to receive proper consideration. Pickling should be done in such a manner that the metal will not be injured. In other words, the acid bath should be made to confine its action to its ascribed purpose, the removal of scale and rust, and be prevented from unduly dissolving and etching the clean metal.

Though the saving in acid and metal, which Rodine makes possible, is a factor responsible for its so general use, there are, however, other factors that at times are of even greater importance. Rodine, in markedly reducing the hydrogen evolved on the metal, logically reduces the amount that can be absorbed into the crystalline structure. It is the absorbed hydrogen that causes the embrittlement of steel wire, bars, springs, etc. It is this absorbed hydrogen that expands in the laminations and faults in sheets giving rise to blisters. Both of these conditions are minimized with Rodine through control of the acid's action.

In the wire industry, use of new Rodine has so reduced the embrittling effect as to make possible merely drying lime coatings in a flash baker in a few minutes instead of baking for many hours in the old-type baker.

**Sheet and Strip Steel**

In the steel industry, millions of tons of sheets and strip are pickled annually. The savings in acid and metal, due to Rodine control of the acid bath, on these large tonnages are huge. Savings in acid and metal are, however, not the only economies that Rodine effects. The savings due to minimizing the scrapping of blistered sheets and reducing the rejections of sheets or strips due to excessively pitted surfaces, with the resultant increase in tin or spelter required to fill pits in the surface, are important though frequently overlooked.

**Pickling Alloy and High Carbon Steel—Stainless Steel**

Alloy and high carbon steels are difficult to pickle. They are attacked rapidly by the acid and, as a result, the surface is roughened and blackened. This violent attack is due largely to the dissimilarity of contacting crystals in the alloys which in the pickling bath form electrolytic couples that in turn set up countless electric currents. These augment the acid's attack on the less noble crystals, thereby preferentially dissolving them and cause the metal to be rough and usually deeply pitted. To offset these characteristics of alloy and high carbon steels, it is of utmost importance to use Rodine. The addition of rock salt to the sulphuric acid pickling bath will lead to better pickled surfaces of alloy steels.

**Pickling Machined and Polished Steel**

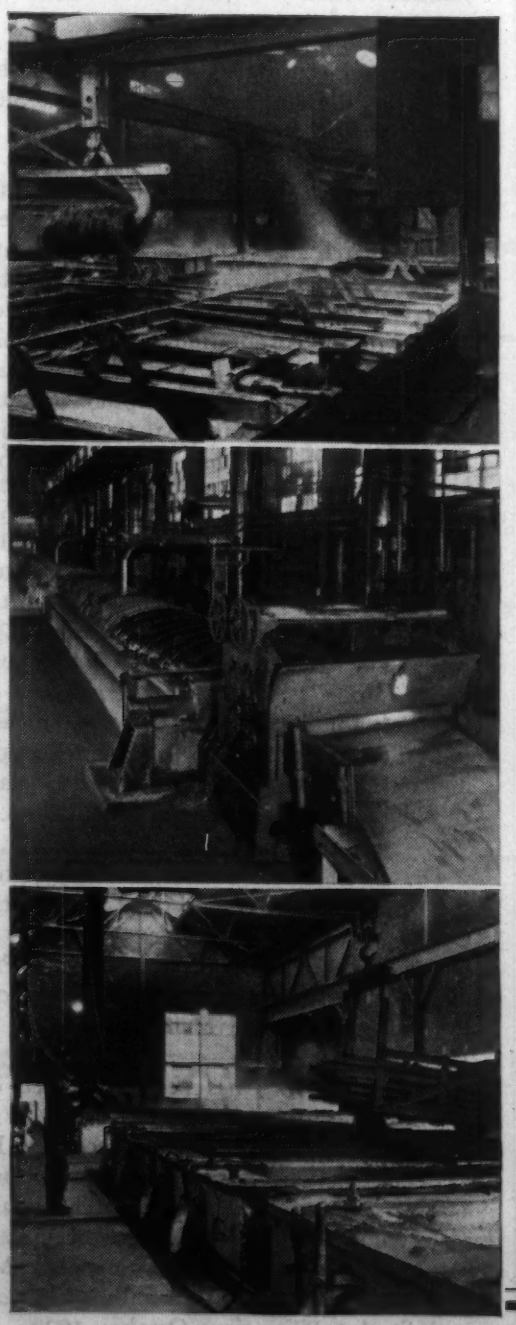
Rust or oxidization from heat treating can be pickled from machined or polished steel without marring the high finish, when Rodine is employed. Even polished and threaded objects may be pickled in a Rodine inhibited bath without damaging threads or changing the dimensions of the work.

**Pickling to Remove Metal Coatings**

In pickling to remove metal coatings, such as zinc, from defective galvanized steel, Rodine prevents the acid from attacking the basis metal without retarding the stripping action.

ADV.—


# RODINE *prevents*



## Needless Waste

**WHEN PICKLING WIRE, SHEET STEEL, STEEL TUBES OR STEEL PRODUCTS IN THE PROCESS OF FABRICATION**

Briefly stated below are a few advantages from the use of RODINE.

- Clean metal is not wasted in pickling.
- Acid is not wasted in dissolving good metal.
- Smoother, brighter, cleaner surfaces are produced.
- Undue etching of the surface of threaded, machined or polished steel is avoided.
- Over-pickling is eliminated.
- Blistering of sheets is reduced.
- Acid brittleness is minimized.
- Uniform pickling is obtained under varying conditions.
- Zinc can be stripped without injuring the basis metal.
- The atmosphere is not contaminated with noxious corrosive gases.

There is a type of RODINE for every pickling problem, depending upon the kind and strength of acid used, upon the nature of the steel, and upon the scale or incrustation to be removed. ACP engineers will gladly recommend the proper RODINE for your particular problem.

*Manufacturers of Inhibitors & Metal Working Chemicals*

**AMERICAN CHEMICAL PAINT CO.**
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★ SIGNAL LIGHT INDICATIONS
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**Completely automatic, ATC T-t controllers provide accurate control of any combination of straight-line heating, soaking or cooling stages. Interwires in circuit of any standard thermocouple and pyrometer-controller (potentiometer or millivoltmeter type). Operating principle has been thoroughly proven in numerous installations over two years. Designs embody greatest flexibility with simple knob settings made once on one instrument. Write for data, outlining your program.**

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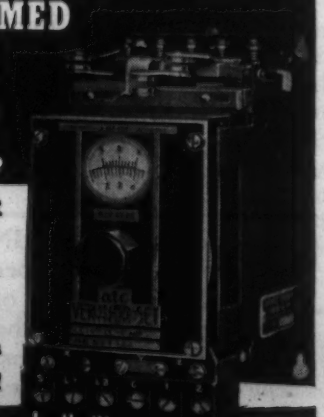

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with ★Bell
★Light
★Foot Switch
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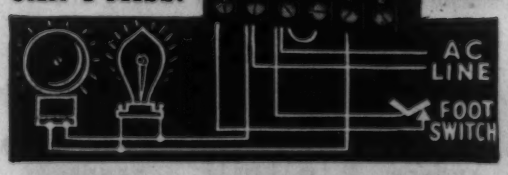


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Ohio. He had previously served as chief metallurgist at Rustless Iron Corp., Bendix Radio Div., and Darlington Rustless Steel & Iron Co., Ltd., Darlington, England.

*Roger J. Metzler,* erstwhile vice president, B. M. Steel Treating Co., Newark, N. J., is now chief metallurgist of Breeze Corporations, Newark.

*S. G. Blowers* has joined the Liberty Heat Treating Corp., Ozone Park, N. Y., as metallurgist in charge of metallurgical control and heat-treating. Mr. Blowers has been in this line of work for 23 years.

*Carl L. Wallfred,* a metallurgist of the Battelle Memorial Institute, Columbus 1, Ohio, has been appointed member of the pilot plant department, Ansul Chemical Co., Marinette, Wis.

*R. H. Thielmann* has been made development engineer, Allegheny Ludlum Steel Corp. He is the author of several technical papers on metallurgy, and was in the research laboratory of General Electric Co. at Schenectady. His major graduate work in Oregon State College was in the field of physical metallurgy and minor work in metals and stress analysis. Since 1941 he has worked on the development of precision, casting processes for casting parts to sizes of high melting point alloys and stainless steels.

*Sam Tour,* of the New York firm of engineers, metallurgists and consultants, has given up his affiliation with Barium Steel Corp. because of press of work.

*Edmund S. Davenport* has been appointed assistant to *R. E. Zimmerman,* vice president, research and technology, United States Steel Corp. of Delaware. Since 1935 he has supervised the work of the metallurgical section of the corporations research laboratory at Kearney, N. J. He has specialized in studies of heat treatment problems, particularly as to the isothermal transformation of steel, for which he has received numerous honors.

*Dr. Laurence C. Hicks,* in the research department of the Allegheny Ludlum Steel Corp. since 1933, has been made metallurgical engineer and associate director of research, magnetic products div., that company. Since 1936 he has researched on materials for the electrical industry, including silicon-iron alloys for magnetic core materials, alloys for sealing metal to glass, and high permeability iron-nickel alloys.

*Dr. William A. Pennington* has joined the research staff, engineering div., Carrier Corp., Syracuse, N. Y., devoting time to metallurgical and chemical problems. Previous connections have been the American Rolling Mill Co. and Mellon Institute.

*W. O. Everling* has been appointed director of research, American Steel & Wire Co., succeeding *J. S. Richards,* deceased. He has held positions with the U. S. Steel Corp. as draftsman, assistant master mechanic and plant engineer. *R. H. Barnes* has been made assistant director of research to replace Mr. Everling. He has been in metallurgical work with Steel & Wire since October, 1920.

HIGH TIME THAT YOU "DISCOVER" STRENES METAL

● This is no idle suggestion for engineers in many lines have tried and adopted Strenes Metal — are regularly specifying it wherever possible.

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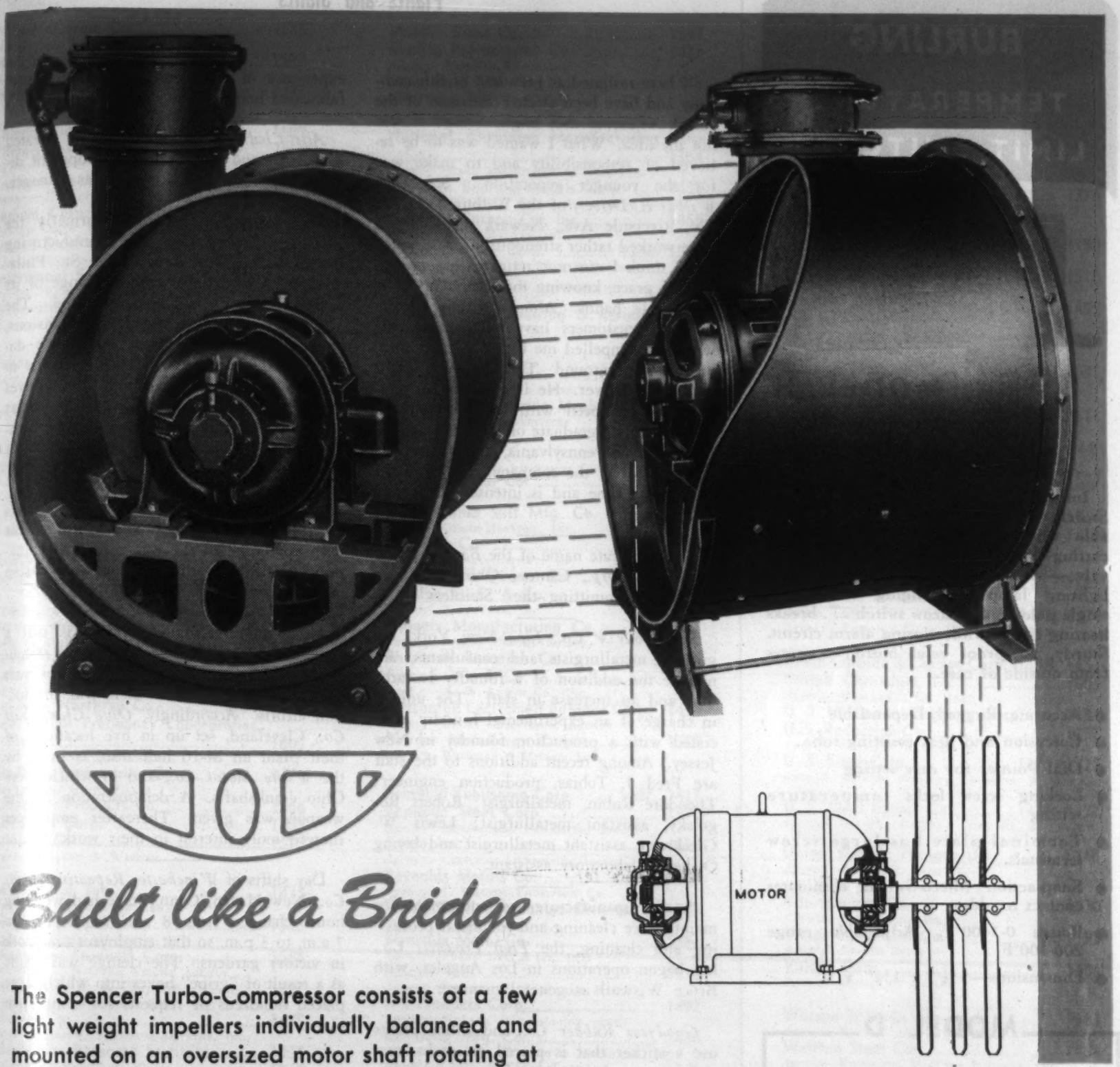


## Built like a Bridge

The Spencer Turbo-Compressor consists of a few light weight impellers individually balanced and mounted on an oversized motor shaft rotating at low peripheral speeds, with wide clearances all around.

The one-piece casing is made of copper bearing steel, rolled and welded. End heads are made of special ribbed sections and spun rings. The motor is supported by a cast bridge-work that evenly distributes the weight.

The Spencer Turbo can be mounted anywhere without special foundations on the floor—or on the side or top of a furnace, with the discharge in any one of four positions.

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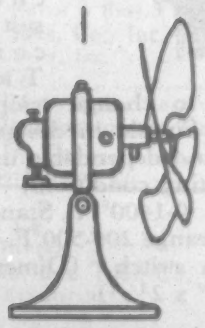

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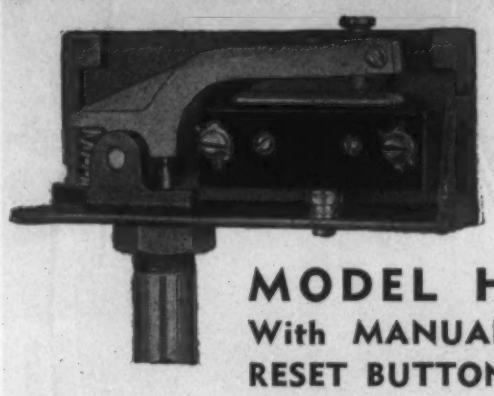
# TURBO-COMPRESSORS

**BURLING**

**TEMPERATURE LIMIT SWITCHES**

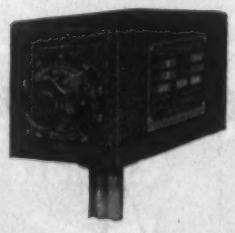


**MODEL H**
**With MANUAL RESET BUTTON**

**Improved High Temperature Safety Switch with Manual Reset Button. Available with switch normally closed for cutting off heat, stopping fan, closing valve—with switch normally open for lighting lamp or ringing bell — with single pole double throw switch . . . breaks heating circuit while closing alarm circuit. Sturdy, foolproof reset button operates from outside of case.**

- **Accurate, Rugged, Dependable**
- **Corrosion and heat resisting tube**
- **Dial Pointer for easy setting**
- **Locking screw locks temperature setting**
- **Terminal plate has large screw terminals.**
- **Snap-action Micro-Switch eliminates contact troubles**
- **Range 0-1400°F. Adjustable range 200-300°F**
- **Dimensions—5⅛" x 1¾" x 3"**

**MODEL D**



**For use where temperatures must be changed to suit operating conditions. Turn outside knob to change temperature setting. Simple in design . . . accurate and dependable under severest operating conditions. Temperature range 0-1400°F. Standard adjustment range 200-500°F. Single snap-action switch. (Dimensions: 5½" x 2¾" x 2¾")**

**Instruments also Built to Specifications**

***Send for Informative Bulletin***

**BURLING INSTRUMENT CO.**
**Springfield Ave. at Livingston St.**
**Newark, N. J.**


# Plants and Slants

"I have resigned as president of this company and have been elected chairman of the board, whatever that might mean; it was not my idea. What I wanted was to be relieved of responsibility and to make way for the younger generation." So states *Wilbur B. Driver,* of the Wilbur B. Driver Co., Riverside Ave., Newark 4, N. J. "I have worked rather strenuously for 55 years, and I think I can now retire with some degree of grace, knowing that the company is in capable hands. Almost without exception our customers have been gentlemen, which has impelled me to try to treat them on that same ground. The new president is Robert O. Driver. He is my son, 37 years old, and has been with the company for 10 yr. He is a graduate of Wharton School, University of Pennsylvania, and owns practical control of the company. He is on the job all the time and is intensely interested in the work."

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The corporate name of the *Barium Stainless Steel Corp.,* Canton, Ohio, has been changed by omitting the "Stainless".

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*Sam Tour & Co., Inc.,* New York, engineers, metallurgists and consultants, announce the addition of a foundry research unit and an increase in staff. The unit is in charge of an experimental foundry associated with a production foundry in New Jersey. Among recent additions to the staff are Fred J. Tobias, production engineer; Theodore Rubin, metallurgist; Robert Rogolsky, assistant metallurgist; Lewis W. Gleekman, assistant metallurgist and Irving Olshever, laboratory assistant.

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A new manufacturer of equipment for maintenance cleaning and for metal processing and cleaning, the *Tivit Products Co.,* has begun operations in Los Angeles, with Bruce Wiswall as general manager.

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*Goodyear Rubber Co.* and other plants use a sticker that is placed on desks, machines or work benches where men now in the armed forces formerly worked. It reads ". . . . . worked here. He is now serving in the armed forces. While he is fighting for you, can you give less than your best for him?" The stickers were devised by *Avery Adhesives,* 451 E. Third St., Los Angeles.

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*The Lithium Co.,* 111 Sylvan Ave., Newark 4, N. J., is building a new plant, building No. 6, on the company's present site. It will be 50 by 125 ft. and will be used for the manufacture of small parts for lithium furnaces as well as cartridges.

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*Yale & Towne Mfg. Co.,* Chrysler Bldg., New York, has bought the scale business of the Kron Co., Bridgeport, Conn., which has made industrial scale equipment for over 25 yr.

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The *U. S. Steel Corp.* has acquired a substantial interest in the *Gunnison Housing Corp.,* New Albany, Ind. This will provide the buyer with the research facilities and experience of an organization serving prefabricated home buyers.

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*Allis-Chalmers,* Milwaukee, has created a research and gas turbine development division, with Dr. J. T. Rettaliata as manager.

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*Selas Corp. of America* (formerly the *Selas Co.*), consulting and manufacturing gas engineers, Erie Ave. and D St., Philadelphia 34, announces official change of its corporate name, as above indicated. The action was necessitated by recent expansions, and by ramifications of the company's domestic and export activities. No change in organization, service, personnel or objectives is implied. In the metals industries, Selas is particularly known for its development work in high-speed localized heat treatment with gas-air combustion.

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Ernest G. Jarvis, president, *Niagara Falls Smelting & Refining Corp.,* Buffalo, has been appointed to the war control termination committee of the National Association of Manufacturers.

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Manufacturers whose product is not a complete unit often have difficulty in stimulating the imagination of their employees as to the importance of their war production efforts. Accordingly, *Ohio Crankshaft Co.,* Cleveland, set up in five locations of their plant an M-16 half trac, as built by the *White Motor Co.,* and in which were Ohio crankshafts. A demonstration of the weapon was given. Thereafter employees showed more interest in their work.

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Day shifts of *Winchester Repeating Arms Co.,* New Haven, Conn., have had working hours changed from 8 a.m. to 5 p.m. to 7 a.m. to 3 p.m. so that employees can work in victory gardens. The change was made as a result of "gripe" boxes into which were placed hundreds of requests for some such plan.

## Meetings and Expositions

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, semi-annual meeting. Pittsburgh, Pa. June 19-22, 1944.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, summer technical meeting. St. Louis, Mo. June 26-30, 1944.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting. New York, N. Y. June 26-30, 1944.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual convention. Cleveland, Ohio. July 19-21, 1944.

INSTITUTE OF AERONAUTICAL SCIENCES, summer meeting. Los Angeles, Calif. July 27-28, 1944.

SOCIETY OF AUTOMOTIVE ENGINEERS, national tractor meeting. Milwaukee, Wis. September 13-15, 1944.

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# trends

*By Edwin F. Cone*

## Steel Company Profits Continue Low

Despite record-breaking wartime production of steel, profits of the steel industry continue below those of many peacetime years, according to the American Iron and Steel Institute. In 1943, net earnings dropped to a new wartime low, representing a return of only 5.1% on investment and 2.8% on volume of sales. In 1942 the record was 5.6% and 3.5% respectively. By comparison the steel industry earned a top peacetime total of $455,000,000 in 1929 when output was 30% less than in 1943. In 7 of the 10 yr. of the 1920's, the industry earned more than it did last year, despite the fact that at no time in that period did steel production amount to more than about 70% of the tonnage made in 1943. Preliminary reports of steel company earnings in the first quarter of 1944 show them to be at approximately the same level as in 1943.

## Manpower and Steel Output

There is a growing deficiency of manpower in the production of steel in American mills. And this is being made up in part by the employment of 50,000 women and by the lengthening of the working time of the remaining employees. Many employees, says the American Iron and Steel Institute, are now doubling up to 16 hr. per day while many others are working 7 days per week to fill in vacancies in regular working crews. The net number of employees is decreasing.

## Scrap in Blast Furnace Charges

The amount of scrap used in the blast furnace has sharply increased, according to a news despatch from Washington, quoting the WPB. Scrap used in the blast furnace in 1943 totaled 3,286,000 gross tons, which is an increase of 21% over the 2,622,000 tons used in 1942 in such furnaces.

## Electric Steel

The trend in the production of electric steel is upward. Using as a basis the data for the first quarter of this year as computed by the American Iron and Steel Institute, the total output of ingots and steel for castings to April 1 was 1,138,601 net tons. This is 43,455 tons in excess of the same period in 1943. The production for the first quarter was at the rate of 379,534 tons per month. In the same period a year ago it was 365,048 tons each month.

## Sound in Testing Castings and Forgings

"Something new has been added" to a well-known method of testing castings or forgings by hitting them with a hammer. When the piece to be tested is struck, the sound is picked up by a microphone and amplified. The harmonic frequencies are then suppressed by a filter, and the remaining base frequency determines whether the casting or forging is defective or not since there is a variation in base frequency between a defective and a perfect specimen.

## Thinnest Wire Ever Made

The thinnest wire ever made is reported in a news item from Schenectady. Invisible platinum wire, so small only its shadow can be seen, is being used experimentally in the laboratory of the General Electric Co. The wire is 13 millionths of an inch thick—25,000 strands would be needed to equal the cross-sectional area of a human hair. When mounted between glass plates and held to the light, the wire is invisible, but when held to the light, the reflection—or shadow—may be seen.

## Magnesium

Today about half of the production of magnesium is used to build and about half to destroy, said Sidney D. Kirkpatrick, president of the Electrochemical Society in a recent address before the New York Electrical Society. Fully 90% of the structural metal goes to the aircraft industry, which only a few years ago used scarcely a pound. Magnesium's future will depend largely on further reductions in its cost and on improvements in the metallurgy of its application.

## Palladium for Jewelry

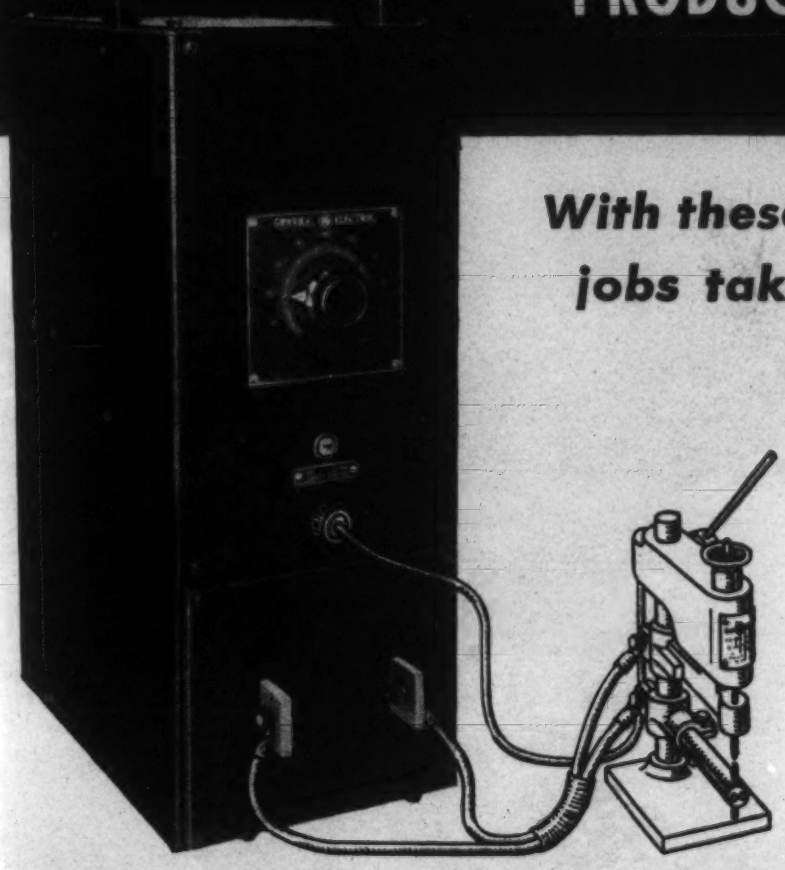
Palladium is taking its place as a commercial and not merely a rare metal. Sales of this metal to jewelry manufacturers have reached a new high record, says Charles Engelhard, president of Baker & Co., Inc., Newark, N. J., refiners and workers of precious metals. "Sales of jewelry palladium have doubled this year over last year and the use of this white precious metal has increased 500% since 1938."

## Electrolytic Tin Plate

Statistics covering the shipments of electrolytic tinplate are now available for the first time from the American Iron and Steel Institute. The quantity is expanding. Shipments rose from 32,418 net tons in January to 39,544 tons in February and to 56,545 tons in March, the latest data. Hot dip output increased similarly.

# SAVE TIN

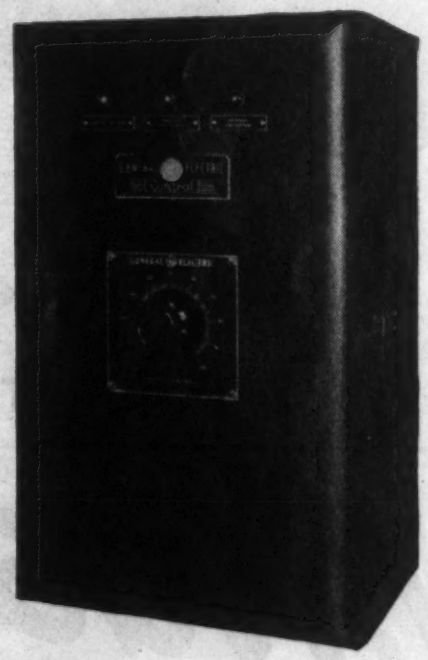
## AND SPEED UP PRODUCTION OF SMALL PARTS



### *With these resistance-welding controls, jobs take half as long as soldering*

**They cut down rejects** by providing accurate control of current and time.

**They save time** by quick, finger-tip adjustment of current and time settings for different welding conditions.



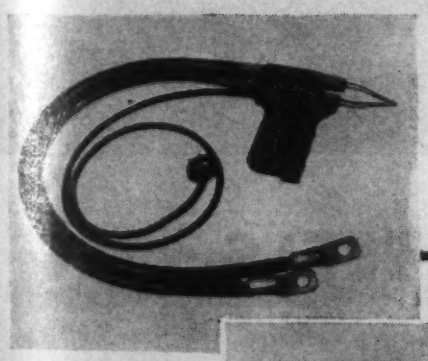
**CR7503-A133**

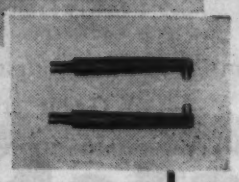
**This control panel, electrically the same as the CR7503-A136, but designed for wall mounting, has no transformer with it. Useful where space is limited, as the control can be remotely located.**

**CR7503-A136**

**This compact, half-cycle, thyratron control panel has a built-in transformer. It can be installed on, or mounted under, the assembly bench. A calibrated dial on the front of the panel provides easy adjustment of the weld time.**

PRODUCTION rates are being stepped up more and more through the use of new and improved, electronically controlled, bench and tong welders. With these welders, the jobs that were impossible yesterday, are done quickly and easily today. With tin and time at a premium, many manufacturers who formerly used soldering have now turned to resistance welding. Another big advantage of resistance welding is that properly welded joints will not come apart at high temperatures.





### NEW TONGS FOR THESE CONTROLS

**These tongs are used with either of the half-cycle controls described when welding small parts in a restricted space. Especially suitable for welding solid or stranded wire to metals such as copper, brass, bronze, steel, ferrous alloys, etc. Tongs are equipped with replaceable tips, and will take other tips made by the user for individual needs. Flux or solder is unnecessary, and the pressure for the weld can be accurately adjusted on the pistol-shaped handle. The weld is made automatically when pressure is exerted on this handle.**

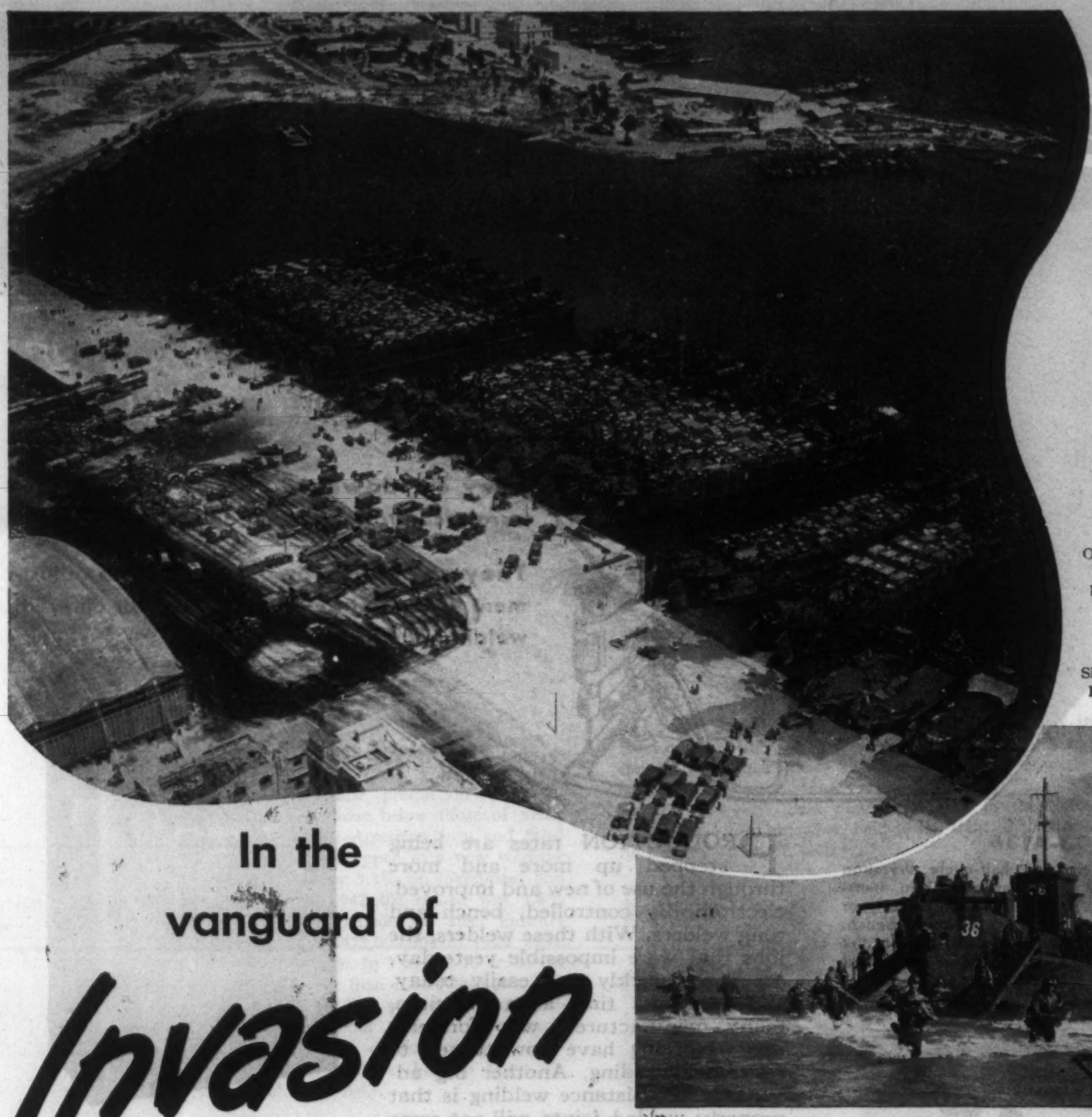
**Do these controls "fill the bill"?**

If you would like complete information on these controls and welding tongs, send today for bulletin (GEA-3045). If these controls aren't the answer to your problem, let us know. We have a complete line of electronic controls for resistance welding. *General Electric, Schenectady 5, N.Y.*

**RESISTANCE-WELDING CONTROL**

**BUY WAR BONDS**

**GENERAL ELECTRIC**



Official U. S. Navy Photograph

Signal Corps. Photograph

In the vanguard of

# Invasion

## GREAT LAKES ALLOY STEELS

Wherever our fighting forces go, Great Lakes Steels go too . . . N-A-X ARMOR PLATE, N-A-X HIGH TENSILE and N-A-X 9100 SERIES STEELS—in practically every type of combat equipment. This widespread war use of these metals is indicative of their importance in the peacetime products of tomorrow. A unique combination of outstanding advantages *guarantees* it . . . (1) Great strength and toughness. (2) High resistance to impact and fatigue. (3) Excellent fabricating features. Write for our booklet on N-A-X Low Alloy Steels. It may start you on a profitable line of thought.

## GREAT LAKES STEEL CORPORATION

DETROIT 18, MICHIGAN

*Sales Offices in Principal Cities*

*Division of* NATIONAL STEEL CORPORATION *Executive Offices, Pittsburgh, Pa.*

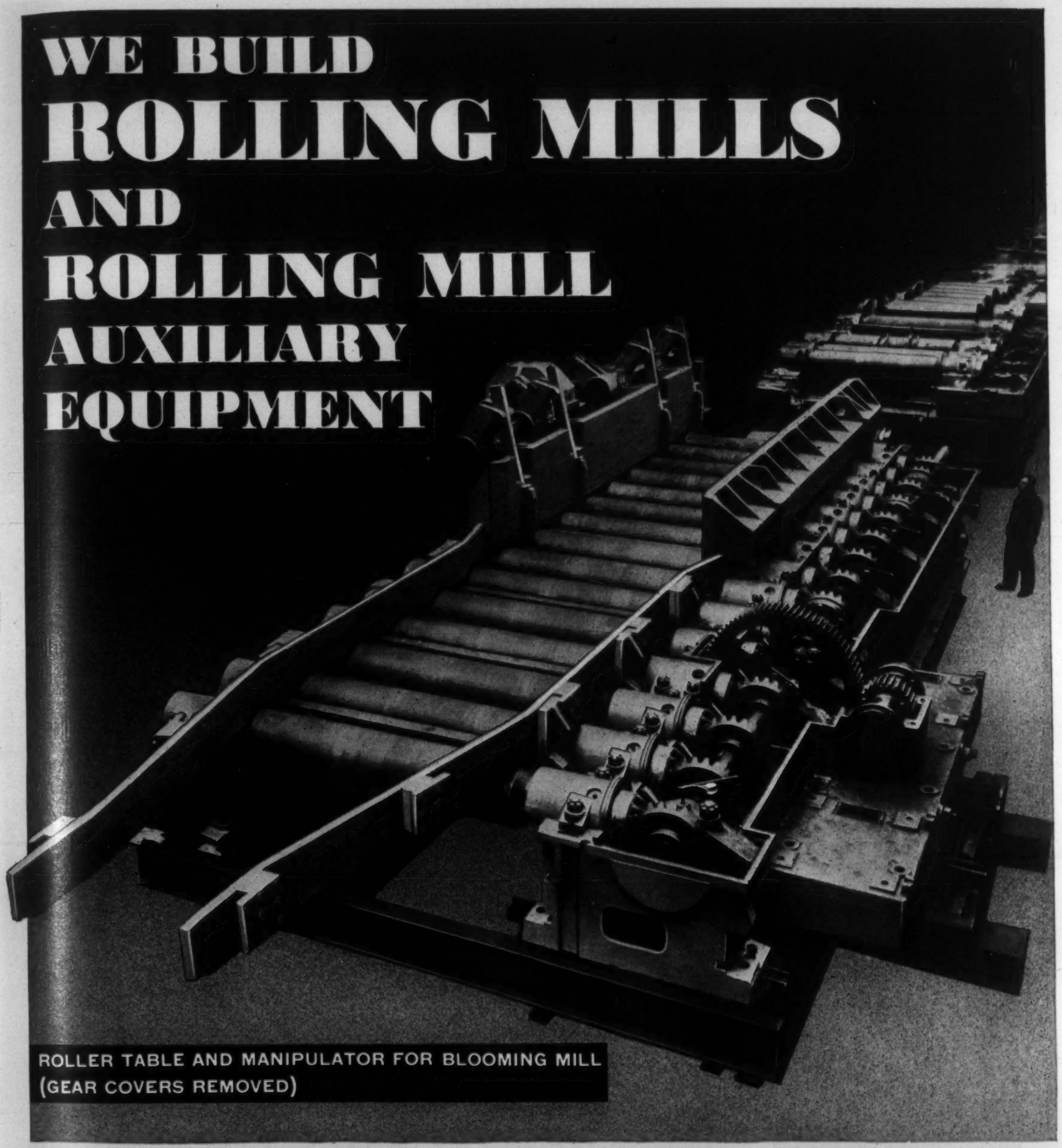
NATIONAL STEEL CORPORATION

DUCTILITY

ITS INHERENTLY FINER GRAIN MAKES ALL THE DIFFERENCE

STRENGTH

# WE BUILD ROLLING MILLS AND ROLLING MILL AUXILIARY EQUIPMENT



ROLLER TABLE AND MANIPULATOR FOR BLOOMING MILL
(GEAR COVERS REMOVED)

# HYDROPRESS · INC.

*ENGINEERS* *CONTRACTORS*

**HYDRAULIC PRESSES · ROLLING MILLS**
**STRETCHERS · PUMPS · ACCUMULATORS**

*570 LEXINGTON AVENUE · NEW YORK · N. Y.*

# YOUR OPERATORS, TOO

## WILL FIND IT EASIER TO MEET SPECIFICATIONS WITH THESE

# PRODUCTION-PROVED ELECTRODES

Copyright, 1944,
General Electric Company

**ARC-WELDING ELECTRODES**

Excellent welding characteristics are assured because each G-E electrode is specifically designed to meet all the requirements of the one A.W.S. classification under which it is listed. No attempt has been made to make any one electrode meet more than one classification, as this invariably requires a sacrifice in performance.

● Once the proper welding procedure is established, the operator can follow it with confidence, knowing that the electrode characteristics will not change. This uniformity of G-E electrode production is maintained by accurately controlled manufacturing and testing procedures.

### *More Reasons Why the Trend is to G-E Electrodes*

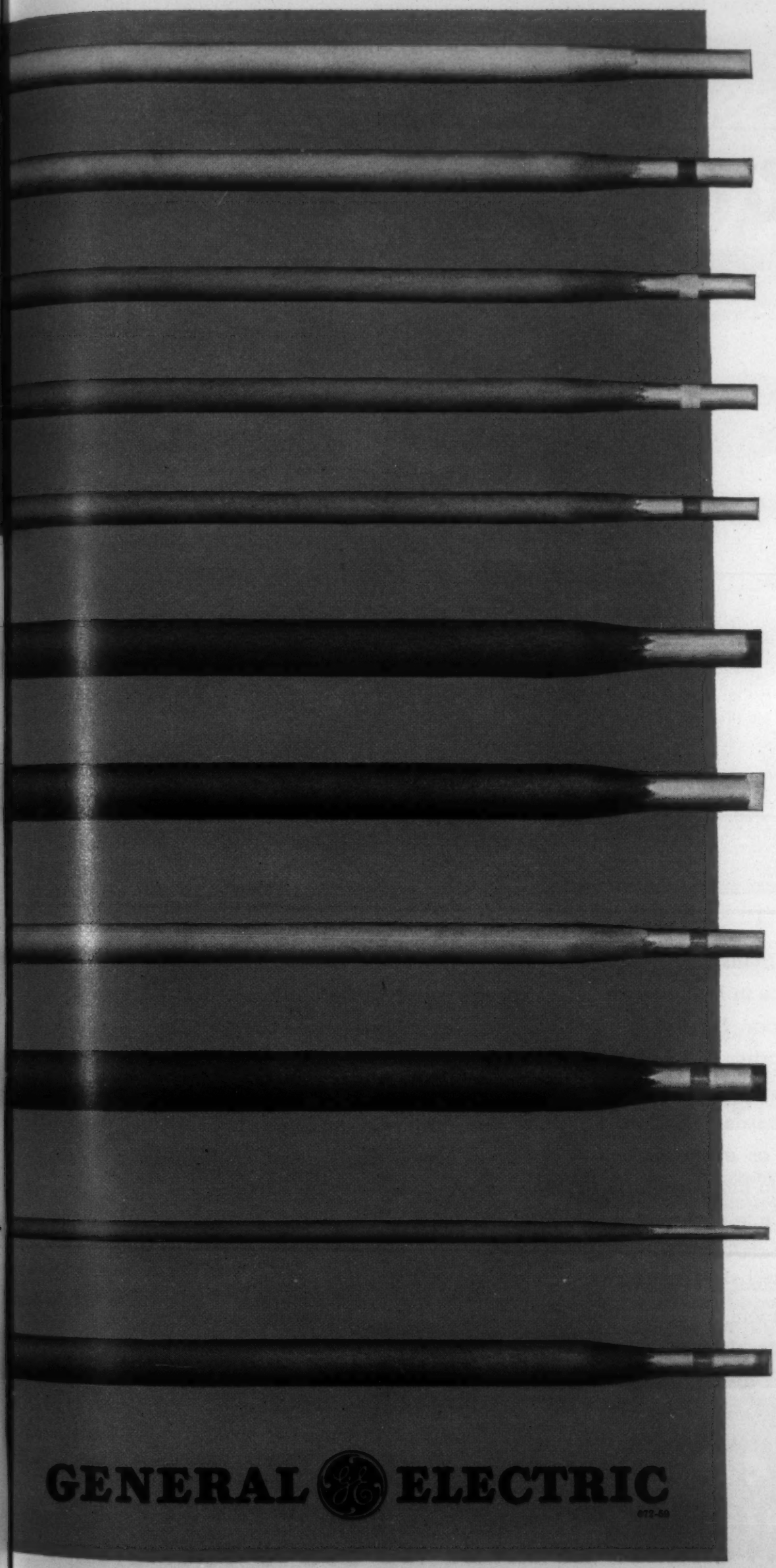
● Production data, printed right on the carton, make it easy to estimate weld-footage per pound for typical joints.

● Each electrode is production-proved in G-E factories and is establishing an outstanding performance record in thousands of shops all over the country.

● The complete engineering and research facilities of the General Electric welding laboratory, and a nation-wide organization of top-ranking welding distributors, are available to every user of G-E electrodes.

● For detailed information and samples of General Electric production-labled arc welding electrodes, and for data on G-E arc welders and welding accessories, simply contact your G-E arc welding distributor or the nearest G-E office, or write to General Electric, Schenectady 5, N. Y.

**Buy all the Bonds you can—and *keep all you buy***




**W-22, A.W.S. E6010**
For high-quality vertical and overhead welding on mild steel with rev-pol d-c. Deep penetration.

**W-26, A.W.S. E6011**
For high-quality vertical and overhead welding on mild steel with a-c. Deep penetration.

**W-20, A.W.S. E6012**
For general all-position welding on mild steel with a-c or straight-polarity d-c. Good for poor fit-up work. Medium penetration.

**W-30, A.W.S. E6012**
For high-speed welding on mild steel with a-c or straight-polarity d-c. Medium penetration.

**W-25, A.W.S. E6013**
For welding light-gage mild steel in any position with a-c or straight-polarity d-c. Light penetration.

**W-24, A.W.S. E6020**
For welding horizontal fillets and flat joints on mild steel with a-c or straight-polarity d-c. Approved for both conventional and deep-fillet techniques. Deep penetration.

**W-23, A.W.S. E6030**
For welding deep-groove joints on mild steel with a-c or straight-polarity d-c. Deep penetration.

**W-52, A.W.S. E7010**
For high-quality vertical and overhead welding on low-alloy, high-tensile steel with reverse-polarity d-c. Deep penetration.

**W-54, A.W.S. E7020**
For welding horizontal fillets and flat joints on low-alloy, high-tensile steel with a-c or straight-polarity d-c. Deep penetration.

**W-83**
For welding cast iron in any position with reverse-polarity d-c or with a-c. Medium penetration.

**W-93**
For building up wear-resisting surfaces using a-c or reserve-polarity d-c. Medium penetration.

# DISTORTION TROUBLES?
# NOT WITH THIS DIE STEEL!

The die-maker, one of the master craftsmen of our time, has every reason for confidence in Bethlehem's Lehigh Die and Tool Steel, H Temper. For this is a steel that is engineered to fight distortion, a problem as old as die-making itself.

High distortion, occurring in the hardening operation, can ruin the labor of days, or even weeks. When an intricate die is machined to limits of a few ten-thousandths of an inch, resistance to deformation is an asset almost beyond value.

That's why Lehigh Die and Tool Steel, H Temper, is one of the aristocrats of the tool room. A product of long study and development, this air-hardening steel shows an absolute minimum of distortion . . . *plus* good machineability, a high degree of toughness, and superlative ability to withstand abrasion. Another characteristic is its unusually hard surface, which is reinforced by excellent deepening properties.

Though primarily air-hardening, Lehigh H Temper can be oil-quenched for greater wear resistance.

You'll find Lehigh H a versatile steel. Besides its uses in die-making, it does a first-class job in such important tools as gauges, punches, taps, rotary slitting cutters, forming and bending rolls, mandrels, shear blades, thread-rolling dies, etc.

BETHLEHEM STEEL COMPANY, Bethlehem, Pa.
BETHLEHEM STEEL EXPORT CORPORATION, New York City

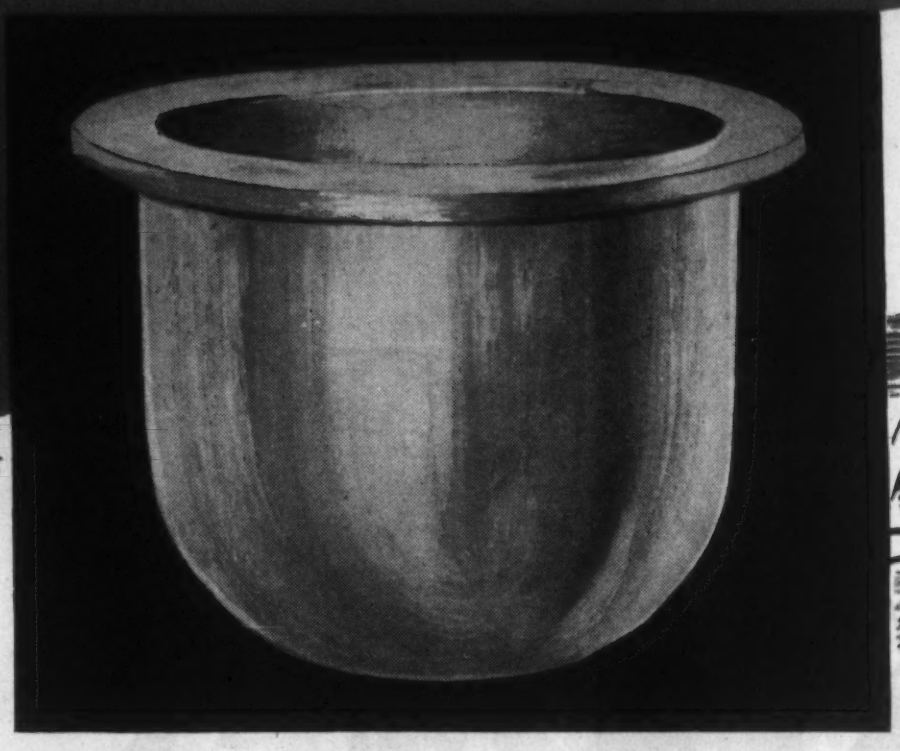
★ ★ ★ BETHLEHEM STEEL ★ ★ ★

***LEHIGH H TEMPER . . . one of Bethlehem's BIG 8 Tool Steels***

# "SWESCO"—The Melting Pot of the Magnesium Industry!

**PRODUCED BY MASS PRODUCTION IN WEIGHTS FROM 50 to 7500 POUNDS**

• Any Size Or Design



WE were well prepared for the coming of the Light Metal Age! For 32 years manufacturers of cast steel melting pots and steel and alloy castings, it was natural for the new Magnesium Industry to look to us for aid in solving many of its problems. "SWESCO" Cast Steel Melting Pots were specially designed for the Magnesium Industry in size, design, chemical and physical analyses. They have also proved highly satisfactory for cyanide, lead and salt baths. Today, "SWESCO" Cast Steel Melting Pots are being used by leading magnesium smelters, die casters, foundries and incendiary bomb manufacturers. For more detailed information phone, write or wire Dept. SCS-5834 today.

GUN MOUNT PEDESTAL

TANK HUB

*We're Helping To Smash The Axis— Thru Mass Production of Steel And Alloy Castings From ½ to 7500 Lbs.*

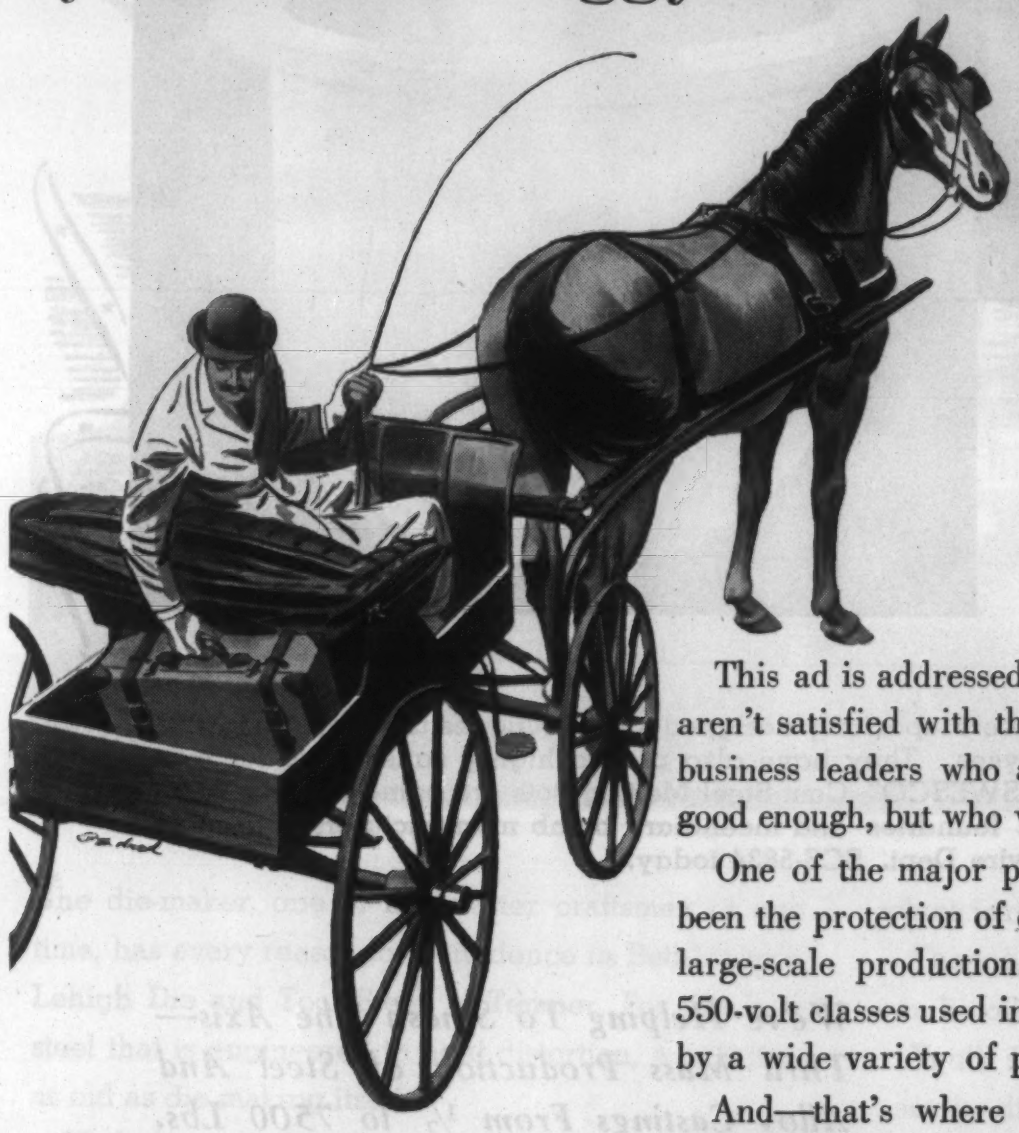
It is our "know-how", born of more than a quarter of a century of experience, that is making a vital contribution towards the speedy defeat of the Axis! The Gun Mount Pedestal and Tank Hub illustrated here are but a few of the many important contributions that we are making for Victory!

• SERVING INDUSTRY FOR MORE THAN THIRTY-TWO YEARS

**Swedish CRUCIBLE STEEL COMPANY**

8561 BUTLER AVENUE . . . DETROIT, MICHIGAN

# IF you're satisfied to travel by horse and buggy...or shave by candlelight



don't read this ad

This ad is addressed to those men in American industry who aren't satisfied with things that are merely "adequate" . . . to business leaders who aren't content with devices that are just good enough, but who want something a bit better than the best.

One of the major problems of modern industry has always been the protection of electrical circuits essential to continuous, large-scale production. These circuits (in the 220, 440, and 550-volt classes used in every plant) have been and are guarded by a wide variety of protective devices.

And—that's where the horse and buggy and shaving by candlelight come in. For, most of these devices—while affording adequate protection—are as out of date as Dobbin and the old straight-edge.

They do the job—there's no doubt about that! But, how do they do it? Are they efficient? And—how much do they cost? . . . These are questions to which every businessman should demand definite answers.

And, gentlemen, if you don't insist on the horse and buggy, here are your answers. J-60557

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

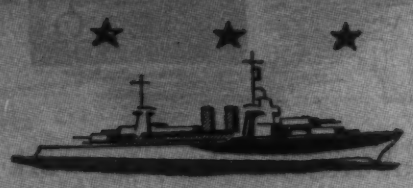
# There's only one modern method of Circuit Protection

# The "DE-ION" (fuseless) CIRCUIT BREAKER of 1944 . . . . .

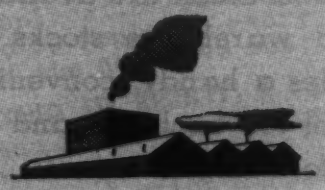
This breaker is as far ahead of ordinary circuit protective devices as is tomorrow's streamlined car by comparison with the old high-wheeled buggy.

And—when compared with previous breakers, it justifies the analogy of the modern fluorescent light and the first carbon bulb.

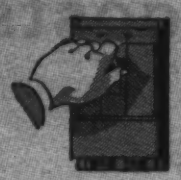
## Here's what the "De-ion" (fuseless) Circuit Breaker of 1944 offers to industry:



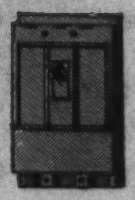
**1. Provides positive "plus" protection** of productive circuits . . . the same protection that controls circuits on modern battleships . . . where failure may mean defeat.



**2. Permits maximum loading** of circuits . . . will not interrupt circuits on harmless momentary overloads . . . prevents many work stoppages and delays . . . completely eliminates need for replacement of protective devices or parts thereof.



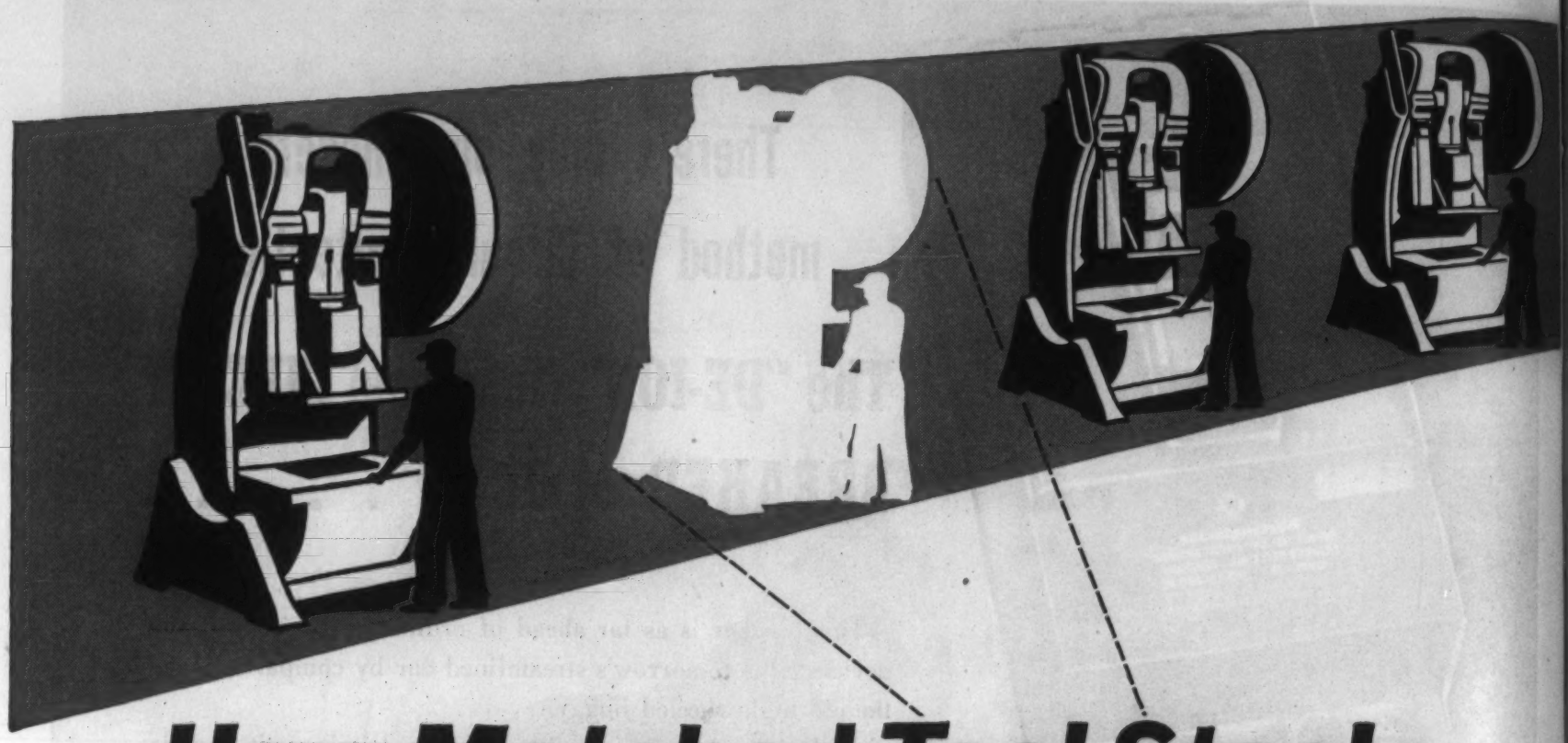
**3. Assures faster resumption of interrupted service** after causes of overloads or short circuits are removed. There is nothing to replace or repair—to restore service, simply throw the handle. This feature alone saves American industry more than one million man-hours yearly.



**4. Guarantees safe operation.** Working parts are completely enclosed and sealed. These breakers are the safest protective devices ever built. They are absolutely tamperproof (cannot be bridged or blocked by pennies, nails or other foreign articles).

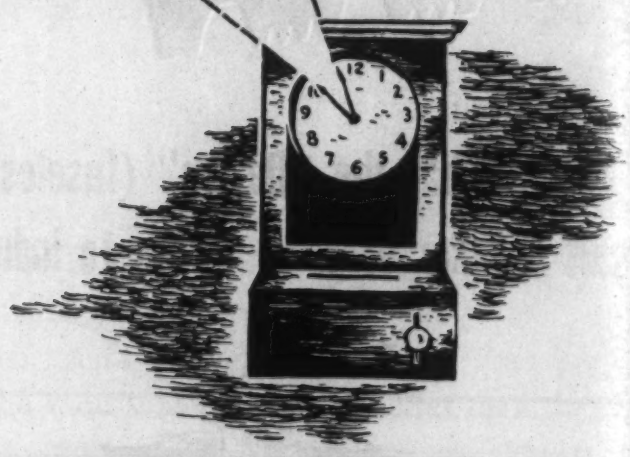
*and* **5. The lifetime cost of the "De-ion" (fuseless) Circuit Breaker of 1944 is less than that of any other protective device.** Ask any Westinghouse representative for facts and figures. Westinghouse Electric & Manufacturing Company, Dept. 7-N, East Pittsburgh, Pa.

**"DE-ION" (*fuseless*) CIRCUIT BREAKERS**



# How Matched Tool Steels

## Reduce "downtime" and cut unit costs...



● Whenever a machine or press must be stopped —output stops—and unit costs go up. The more "downtime", the higher those unit costs go.

Excessive "downtime" is often directly traceable to tools that require too frequent maintenance attention—regrinding, repairing or replacement.

Many a man responsible for tools has made the discovery that much tool-caused "downtime" is unnecessary and can be eliminated — with the help of Carpenter Matched Tool Steels.

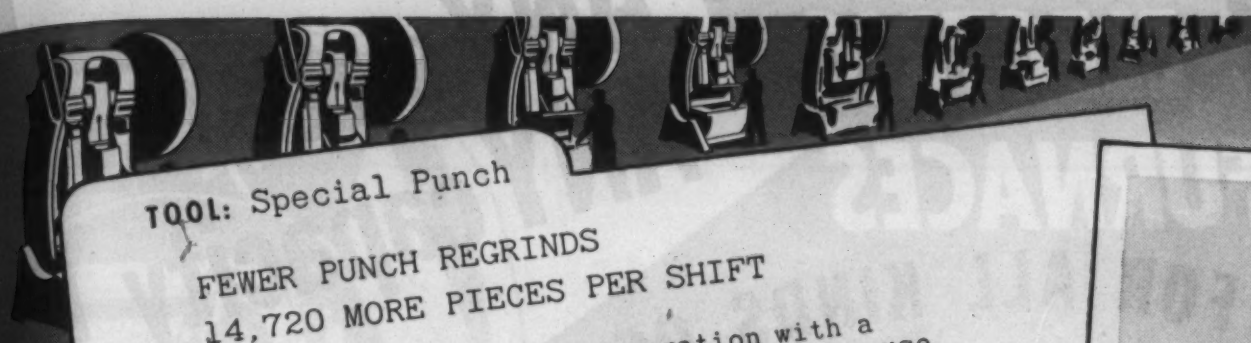
1. Because these 9 Tool Steels simplify selection—and help you get the right tool steel for maximum service on each job.

2. Because correct and easy-to-use heat treating instructions are furnished for each steel to safeguard hardening results and step up tool performance.

These advantages make Carpenter Matched Tool Steels easier to use in the tool room—and assure tools and dies that stay on the job—work more consecutive hours with less maintenance. The result is higher machine output and lower unit costs.

Carpenter Matched Tool Steels are available from conveniently located warehouse stocks. A 168 page manual provides a handy, convenient way to find the right steel for each job and supplies full and complete information on analysis, physicals, working properties, and heat treatment. This manual is available from your Carpenter representative. Ask him for a copy—or write us, on your company letterhead, giving position or title, please.

**The Carpenter Steel Company • 135 W. Bern Street • Reading, Pa.**

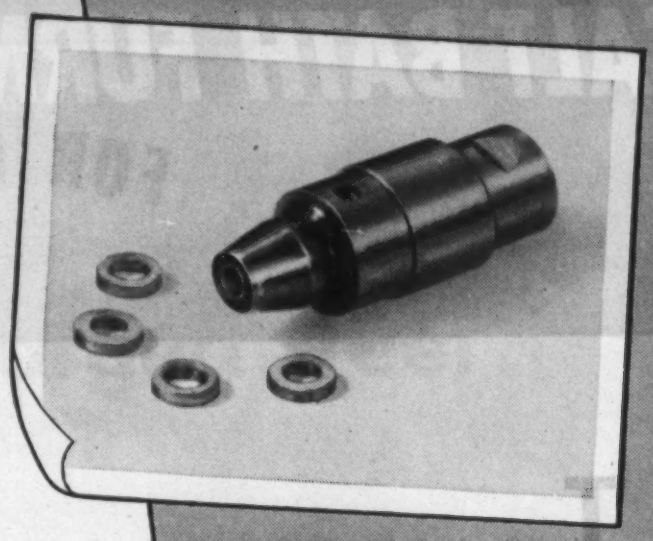


**TOOL:** Special Punch

FEWER PUNCH REGRINDS
14,720 MORE PIECES PER SHIFT

**THE JOB:** A high speed press operation with a 4 gang punch setup. Washers for military use were produced from highly abrasive rubberized sheet asbestos. To maintain close tolerance and cut clean required three shut-downs daily to regrind punches.

**MATCHED SET RESULTS:** By the Carpenter Matched Set Method a steel was selected for maximum abrasion resistance—number of shut-downs for grinding tools was cut from three to one per machine per day. Output increased 14,720 pieces per day. Three hours of tool room time saved every day for each press by reduction in punch regrinding.

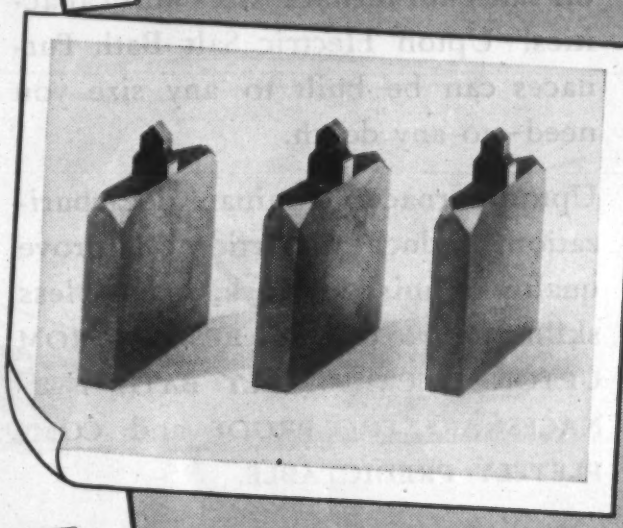


**TOOL:** Swaging Die

TIME BETWEEN GRINDS TRIPLED
PRODUCTION PER SHIFT UP 2344 UNITS

**THE JOB:** A large production swaging operation in which a grooving knife was used to work SAE 6150. Excessive wear required resharpening of grooving knife once a day.

**MATCHED SET RESULTS:** From the Carpenter Matched Set of tool steels a steel was selected to give maximum wear and hardening accuracy. Production time between tool regrinds was more than tripled and each 8 hour shift production increased an average of 2344 units.



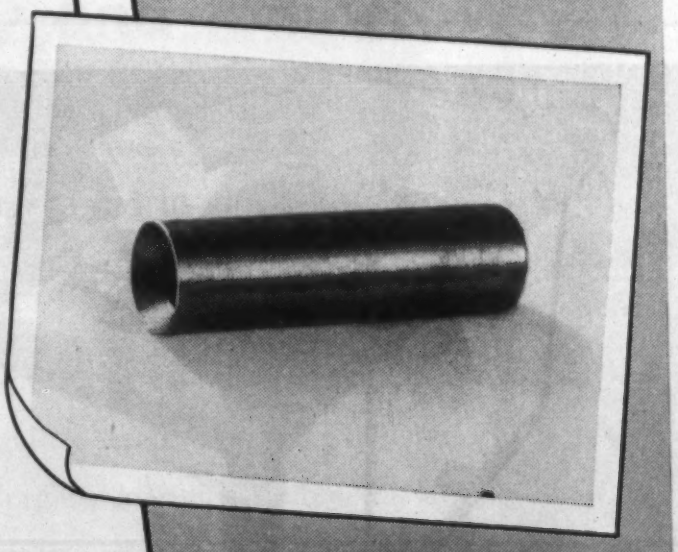
**TOOL:** Sizing Die

PRODUCTION INTERRUPTIONS CUT 75%
1800 MORE PIECES PER SHIFT

**THE JOB:** An extruding operation whereby a flux coating is applied to welding wire. A sizing die in the hydraulic press insured application of a uniform wire coating. Dies had to be replaced every two hours because of the abrasive wear:

**MATCHED SET RESULTS:** A Carpenter Matched Tool Steel was selected for greatest wear resistance with these results:

1. Production stoppages to replace dies, cut from 4 to 1 per day.
2. Die life was increased by 400%.
3. 1800 more pieces of vitally needed welding rod were produced per shift.




*Carpenter* MATCHED TOOL STEELS

BRANCHES AT Chicago, Cleveland, Detroit, Hartford, St. Louis, Indianapolis, New York, Philadelphia

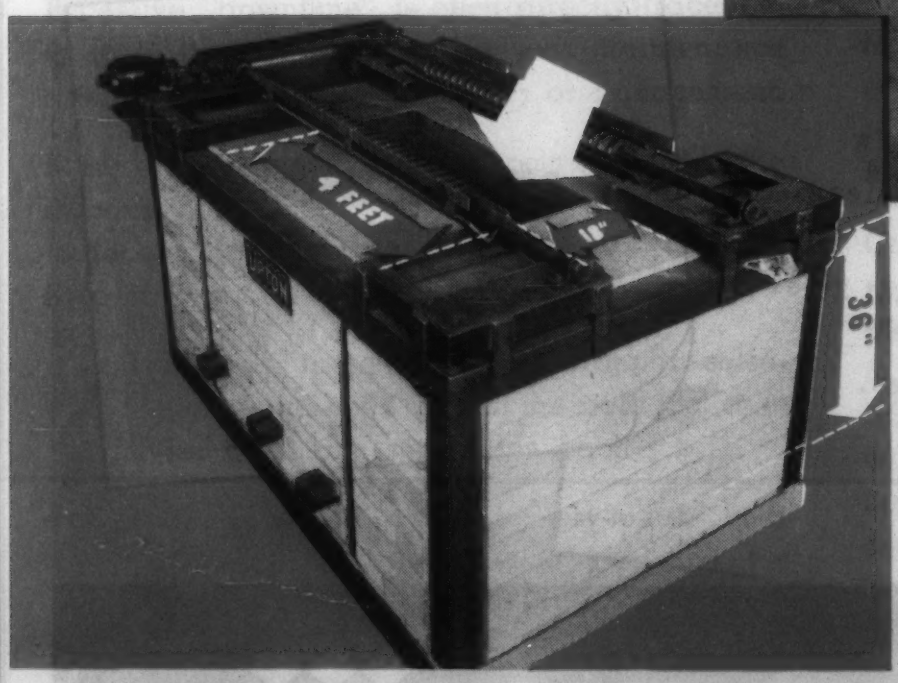
# Upton ELECTRIC SALT BATH FURNACES

## in ANY size ANY capacity

### FOR ALL KINDS OF HEAT TREATING

The Sealed Electrode method of heating has tossed out all restrictions on salt bath furnace sizes and capacities! Upton Electric Salt Bath Furnaces can be built to any size you need—to any depth.

Upton Furnaces eliminate decarburization, reduce distortion, improve quality of finished work, require less skilled help to operate. RESULTS FROM UPTON ELECTRIC SALT BATH FURNACES ARE FOOLPROOF and COMPLETELY PREDICTABLE.



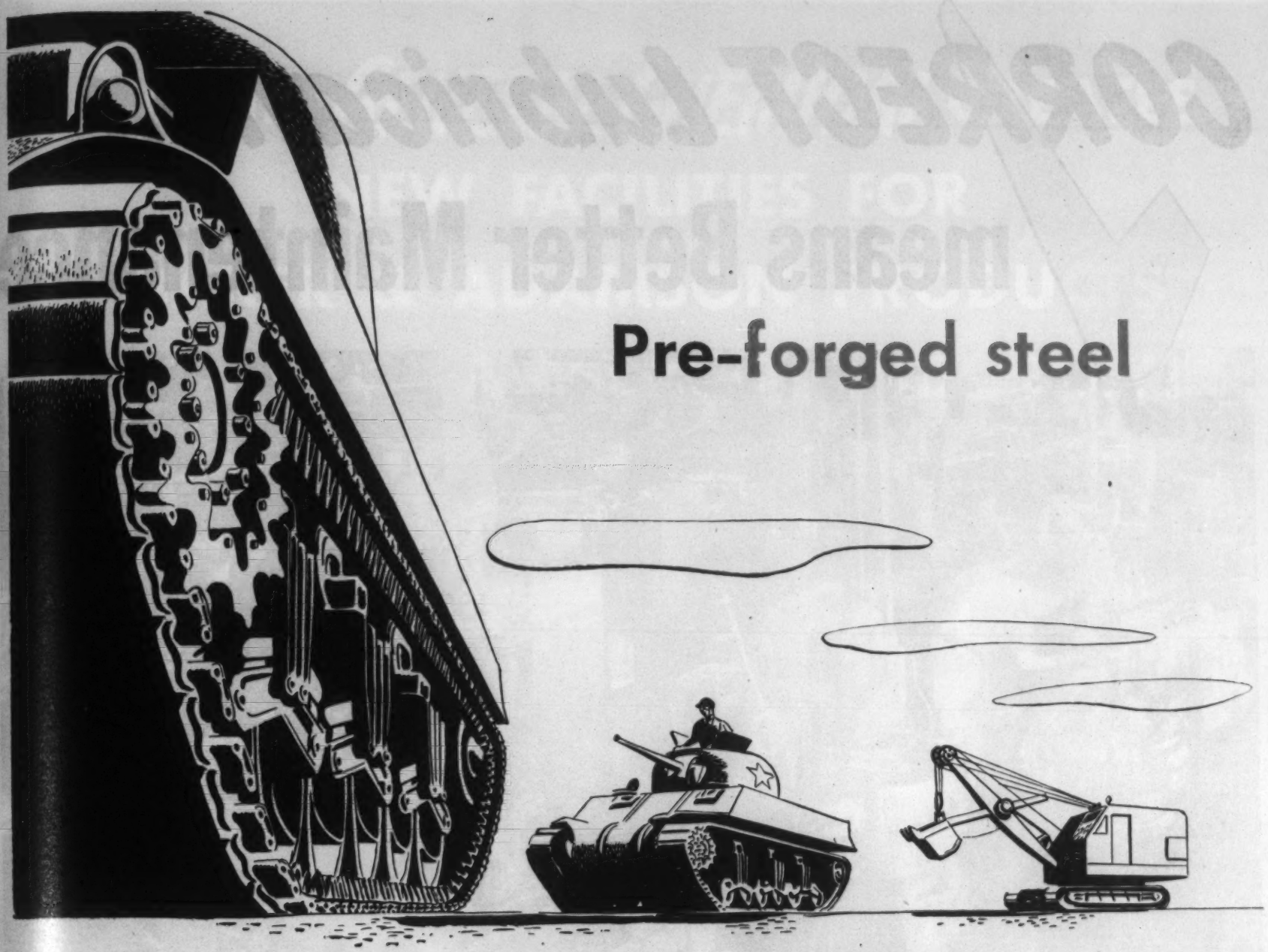

**These furnaces nearing completion, indicate some of the sizes that are available in Upton Electric Salt Bath Furnaces. The long (21'-0") furnace in the foreground is for continuous anneal of brass cartridge cases. The other vertical furnaces are for High Speed and Moly Steel hardening. Other sizes are as readily available.**

***Ask for complete information now; Please mention the type of work to be heat treated.***

# Upton ELECTRIC FURNACE DIV.

COMMERCE PATTERN FOUNDRY AND MACHINE COMPANY

7425 MELVILLE AT GREEN — DETROIT 17, MICHIGAN




# —for the tough jobs of today and tomorrow

Follansbee is furnishing alloy steels for a wide variety of uses in the thick of the fight. Steels which are employed in such diversified forms as sprockets for landing craft, transmission gears in tanks and heavy trucks, propeller hubs, landing struts for heavy bombers . . .

The war's end will not end the tough jobs for steel—and tomorrow will bring additional demands on the ingenuity and craftsmanship of those who work with steel. Follansbee can be depended upon to serve these needs with the same ability and dispatch that have always distinguished its record.

Follansbee's compact organization, using small basic open hearth furnaces, exercises the close, skillful control—from start to finish—which is essential in high grade alloy steels. And its exclusive Pre-Forging process—forging ingots into blooms and billets—is extra assurance of the sound steels needed for the tough jobs of today *and* tomorrow.

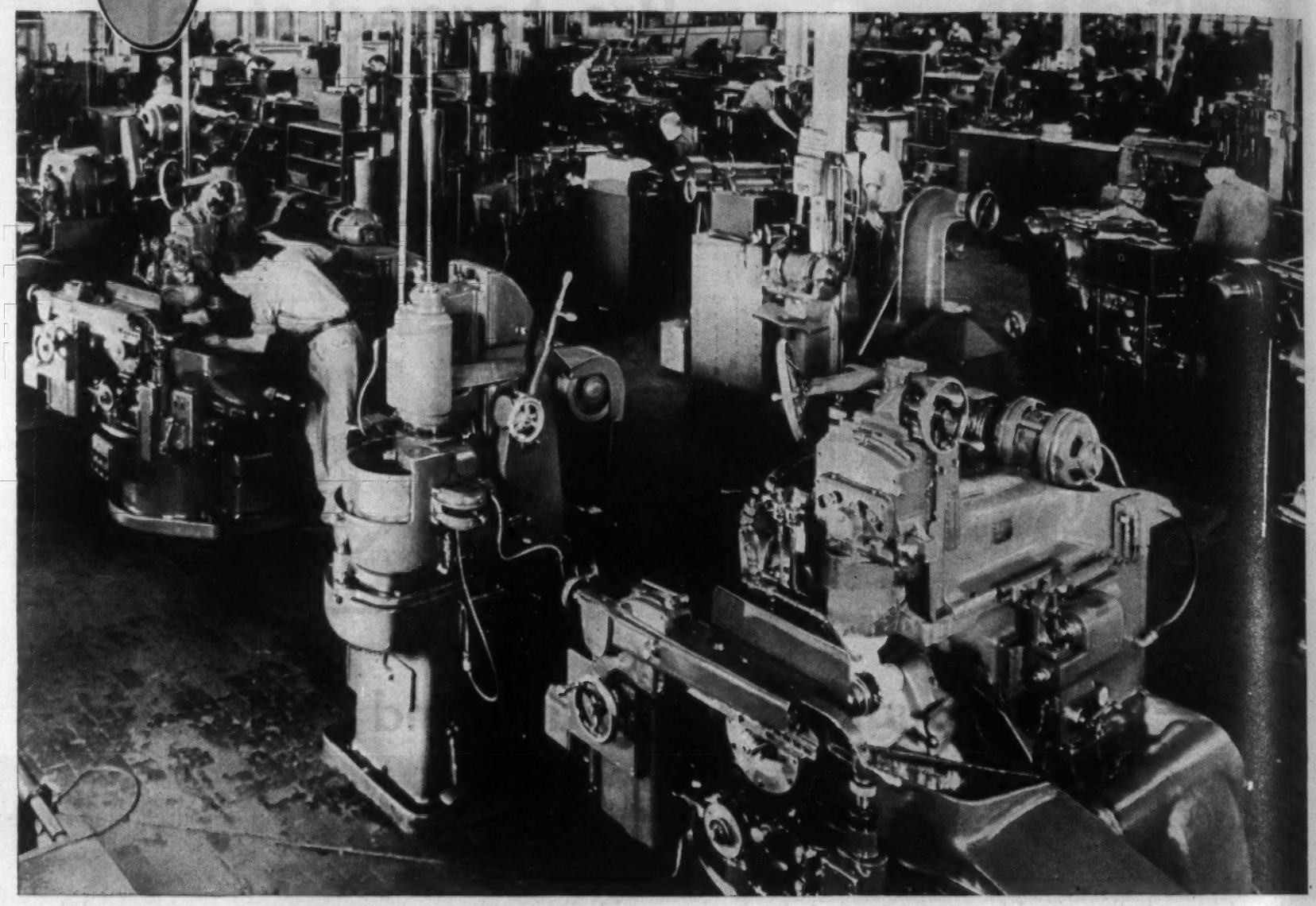
## FOLLANSBEE STEEL CORPORATION

GENERAL OFFICES • PITTSBURGH 30, PA.

*Sales Offices*—New York, Rochester, Cleveland, Detroit, Milwaukee. *Sales Agents*—Chicago, St. Louis, Nashville, Los Angeles, Toronto and Montreal, Canada. *Plants*—Follansbee, W. Va. and Toronto, Ohio

ALLOY BLOOMS, BILLETS, BARS, SHEETS & STRIP • COLD ROLLED SHEETS & STRIP
POLISHED BLUE SHEETS • ELECTRICAL SHEETS & STRIP • SEAMLESS TERNE ROLL ROOFING

# CORRECT Lubrication means Better Maintenance



**CORRECT** lubrication makes for better maintenance by preventing excessive wear.

Sinclair provides a range of specialized hydraulic, spindle, gear, and general purpose oils for *correct* lubrication of *MACHINING* equipment . . . also a widely diversified line of cutting oils adapted to every problem.

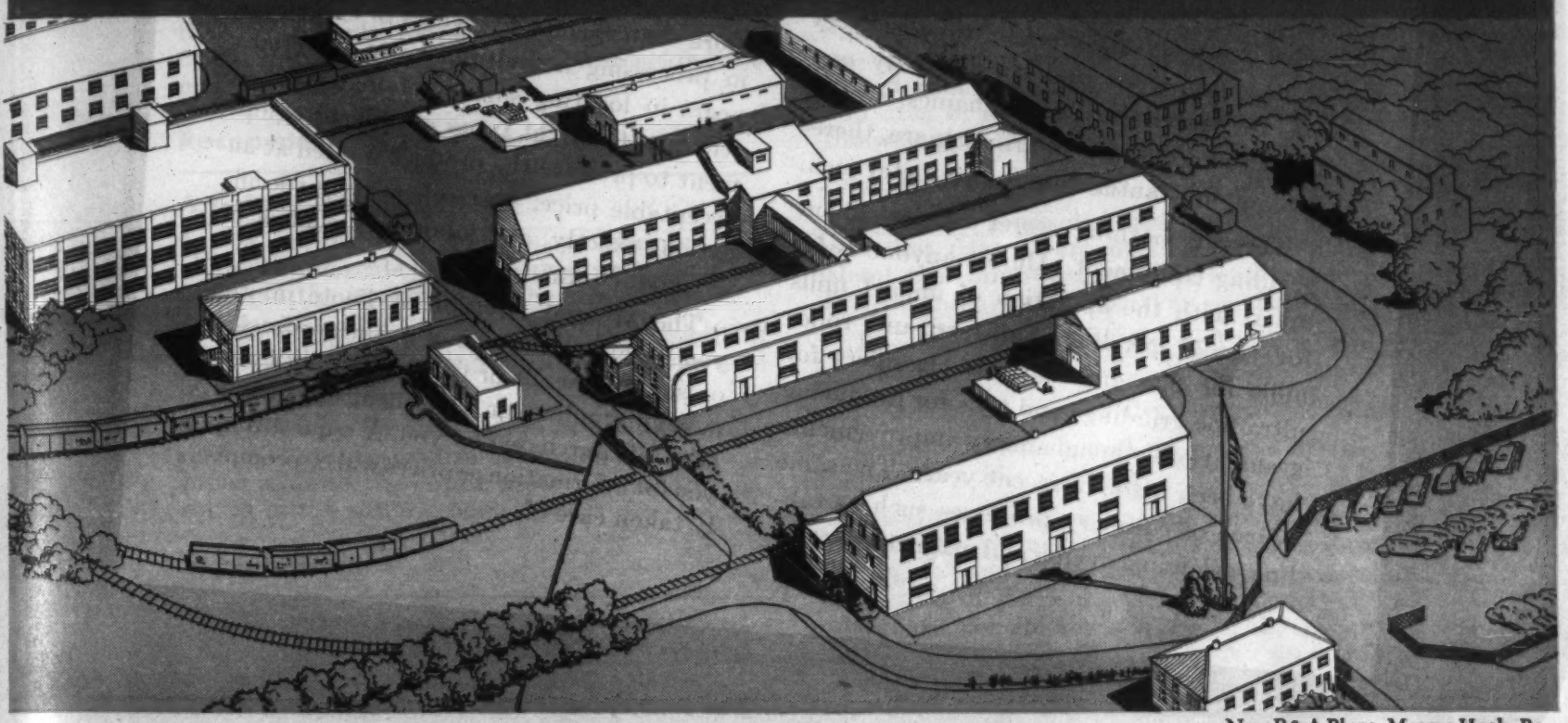
Where overtime heavy duty operation threatens excessive wear and machine stoppages there is a lubrication problem. Consult us about it.

*(Write for "The Service Factor" — published periodically and devoted to the solution of lubricating problems.)*

## SINCLAIR INDUSTRIAL OILS

FOR FULL INFORMATION OR LUBRICATION COUNSEL WRITE SINCLAIR REFINING COMPANY, 630 FIFTH AVENUE, NEW YORK 20, N. Y.

# AGAIN *GENERAL CHEMICAL* CREATES NEW FACILITIES FOR BAKER & ADAMSON PRODUCTS TO SERVE AMERICAN INDUSTRY!



New B&A Plant, Marcus Hook, Pa.

THESE NEW FACILITIES for production of Baker & Adamson reagent and fine chemicals provide ideal manufacturing areas, additional research and development laboratories, and special storage and shipping accommodations. This plant's output, coupled with that of other Baker & Adamson producing units and distributing stations throughout the United States, marks another forward step in Baker & Adamson leadership.

Basic materials for many Baker & Adamson quality products made here come directly from sixteen of General Chemical Company's producing locations. With such fundamental sources of supply, including many Company-owned mines for raw materials, Baker & Adamson is in a pre-eminent and unique position for meeting the expanding uses of high-purity chemicals in industry.

Whether you require laboratory reagents, fine chemicals, or other products prepared in accordance with your formulae—avail yourself of the Baker & Adamson facilities. Experienced technical service representatives are ready to discuss *your* chemical problems and requirements. Baker & Adamson stocks are carried in many principal cities!

GENERAL CHEMICAL COMPANY

*Fine Chemicals for Industrial America*

**GENERAL CHEMICAL COMPANY**

40 RECTOR STREET, NEW YORK 6, N. Y.

Technical Service Offices: Atlanta • Baltimore • Boston • Bridgeport (Conn.) • Buffalo • Charlotte (N.C.) Chicago • Cleveland • Denver • Detroit • Houston • Kansas City • Milwaukee • Minneapolis New York • Philadelphia • Pittsburgh • Providence (R. I.) • St. Louis • Utica (N. Y.)

*Pacific Coast Technical Service Offices:*

Los Angeles • San Francisco • Seattle, Wenatchee and Yakima (Wash.)

In Canada: The Nichols Chemical Company, Limited • Montreal • Toronto • Vancouver

# FACTS YOU SHOULD KNOW ABOUT CUSTOM-GRINDING ORES AND MINERALS

THE REDUCTION in size of ores and minerals by grinding is a process probably as old as man. Progress generally has been in the direction of finer particle sizes, and, curiously enough, production of finer particles is usually attended by the discovery of new properties and consequently new uses for materials. The mechanics, advantages and economics of grinding are, therefore, of substantial interest to metal men.

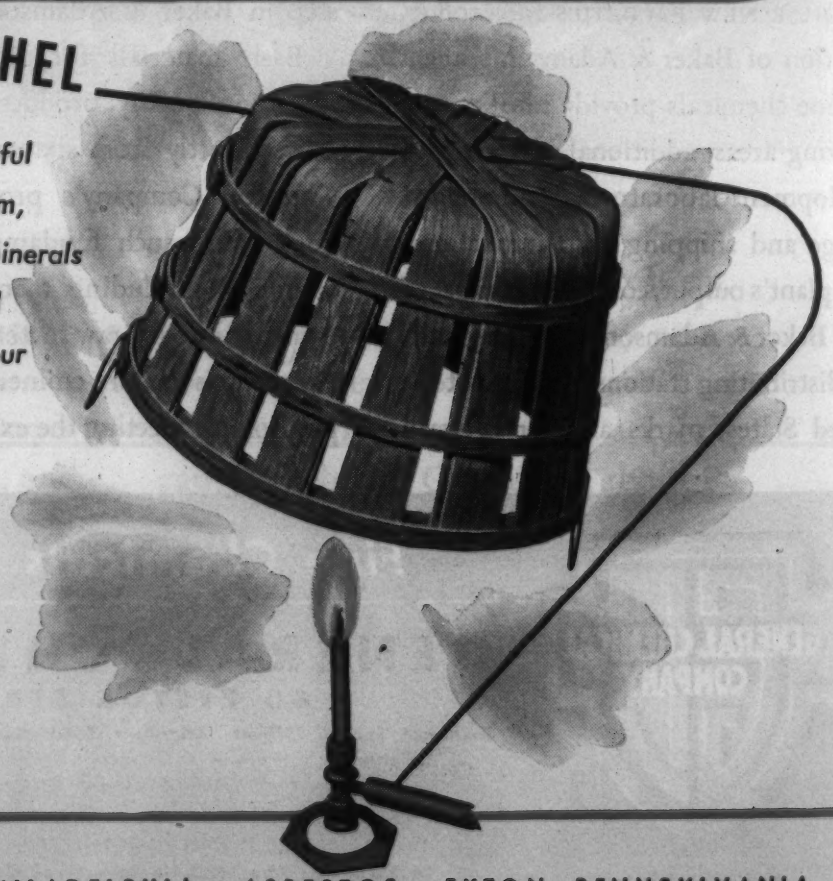
There is nothing secret or new about grinding equipment. Almost anyone is familiar with the operation of impact mills for coarse grinding, ball-race and roller mills for fine grinding, air classifiers for ultra fine grindings and rolls for producing granulation—though many improvements have been made in recent years. The same is true of corollary processes such as tabling, calcining, drying and magnetic separation. Our several plants have a wide diversity and large number of all these types of equipment for custom grinding, beneficiating or treating a great variety of ores and minerals.

More important to you, perhaps, is our more than twenty-five years of experience in processing a multiplicity of materials, years in locating sources of materials, in selecting the right types of mills or equipment to produce the product wanted at an acceptable price, years of meeting specifications exactly, and laboratory control of all production.

The Mineral Division of Foote invites you to take advantage of its own processed ores and minerals or to use its facilities for custom-grinding or treatment of ores or minerals purchased by you. A request from you for information or prices will be promptly taken care of.

## THE LIGHT UNDER OUR BUSHEL

*If there be a light under our "bushel" it is the purposeful glow of a Bunson burner, throwing new light on lithium, strontium, zirconium and a host of other ores and minerals packed with industrial possibilities. Through research and processing Foote brings new ideas and products to your eyes; works with you in their development. Now is the time to let us help you take advantage of Foote research and manufacture.*



Foote
MINERAL COMPANY
*A Step Ahead in Industrial Ores and Chemicals*

PHILADELPHIA • ASBESTOS • EXTON, PENNSYLVANIA
Home Office: 1609 SUMMER STREET, PHILADELPHIA, PA.
West Coast Repr.: Griffin Chemical Co., San Francisco, Calif. • English Repr.: Ernst B. Westman, Ltd., London, Engl

**Headline News from the Notebooks of Monsanto Technical Servicemen**

# How to Pickle Copper- or Brass-clad Steel Completely . . . In One Bath . . . With Ferrisul

## The Problem:

To provide a pickling solution drastic enough to remove *all three* types of scale encountered in a copper- or brass-clad steel . . . especially the very difficult, red, cuprous scale on the surface metal . . . *without* excessively attacking the metals themselves.

## Recommended Solution:

A pickling bath including:

1. *8% sulfuric acid* (66°Be) to dissolve the black, cupric scale on the copper or brass cladding and the iron scale on the steel "filler."

2. *0 to 0.5% Hibitite* (based on the weight of the sulfuric acid), to inhibit attack of the acid on the base steel.

3. *2 to 15% Ferrisul*, Monsanto's anhydrous ferric sulfate, to oxidize the stubborn, red, cuprous scale to the cupric state in which it dissolves in the sulfuric acid.

## Explanation:

The exact percentages of Ferrisul and Hibitite would vary between the wide limits given above depending on the amount of red scale, the pickling time permitted, etc. For example, if the red scale is not removed readily in the time permitted, the Ferrisul percentage would be increased toward the upper limit given. If it is removed completely, the Ferrisul could be decreased.

As for the percentage of inhibitor used, this should be increased toward the upper limit if there seems to be excessive acid attack on the steel . . . or decreased if it slows up the removal of red, cuprous scale.

Temperature of the pickling bath might vary over a wide range but would probably be between 140° and 180°F. In general, the higher the temperature, the more rapid the pickling action.

## Costs:

Since Ferrisul use-up is faster than sulfuric acid use-up, the chief cost is that of the Ferrisul consumed, and this will depend on the type of scale and area of surfaces being pickled rather than the weight of the metal.

As a specific example:

Fifty calibre brass-clad steel bullet jackets, cups and first draw, were pickled in one plant for about two minutes at 180°F. in a rotary pickling machine with a solution consisting of:

12% sulfuric acid (66°Be) or 1.07 lbs. per gal. of solution

5% Ferrisul or 0.42 lbs. per gal. of solution

0.15% Hibitite based on weight of the sulfuric acid.

Ferrisul was consumed at the rate of one pound for 160 lbs. of metal with an estimated area of 40 sq. ft. and sulfuric acid use-up was about 20% that of Ferrisul. At 2c per lb. for Ferrisul and 1¼c per lb. for sulfuric acid, this meant a total chemical cost of 2¼c for 40 sq. ft. or 56c per 1,000 sq. ft. since cost of the inhibitor was negligible.

## Handling Ferrisul:

Ferrisul is a dry, granular powder which is easy to store, safe to handle and not difficult to add to pickling solutions if the necessary precautions are observed.

For further information and experienced technical advice on adapting Ferrisul to your particular problems, write or wire: MONSANTO CHEMICAL COMPANY, Merrimac Division, Everett Station, Boston 49, Massachusetts.

**FERRISUL** also has marked advantages for

- pickling copper and its alloys
- pickling 18.8 stainless steel
- etching steel
- pickling nickel
- etching low alloy steel
- pickling aluminum bronze
- pickling straight chrome steel

MONSANTO CHEMICALS
SERVING INDUSTRY...WHICH SERVES MANKIND

# Yoloy Pipe

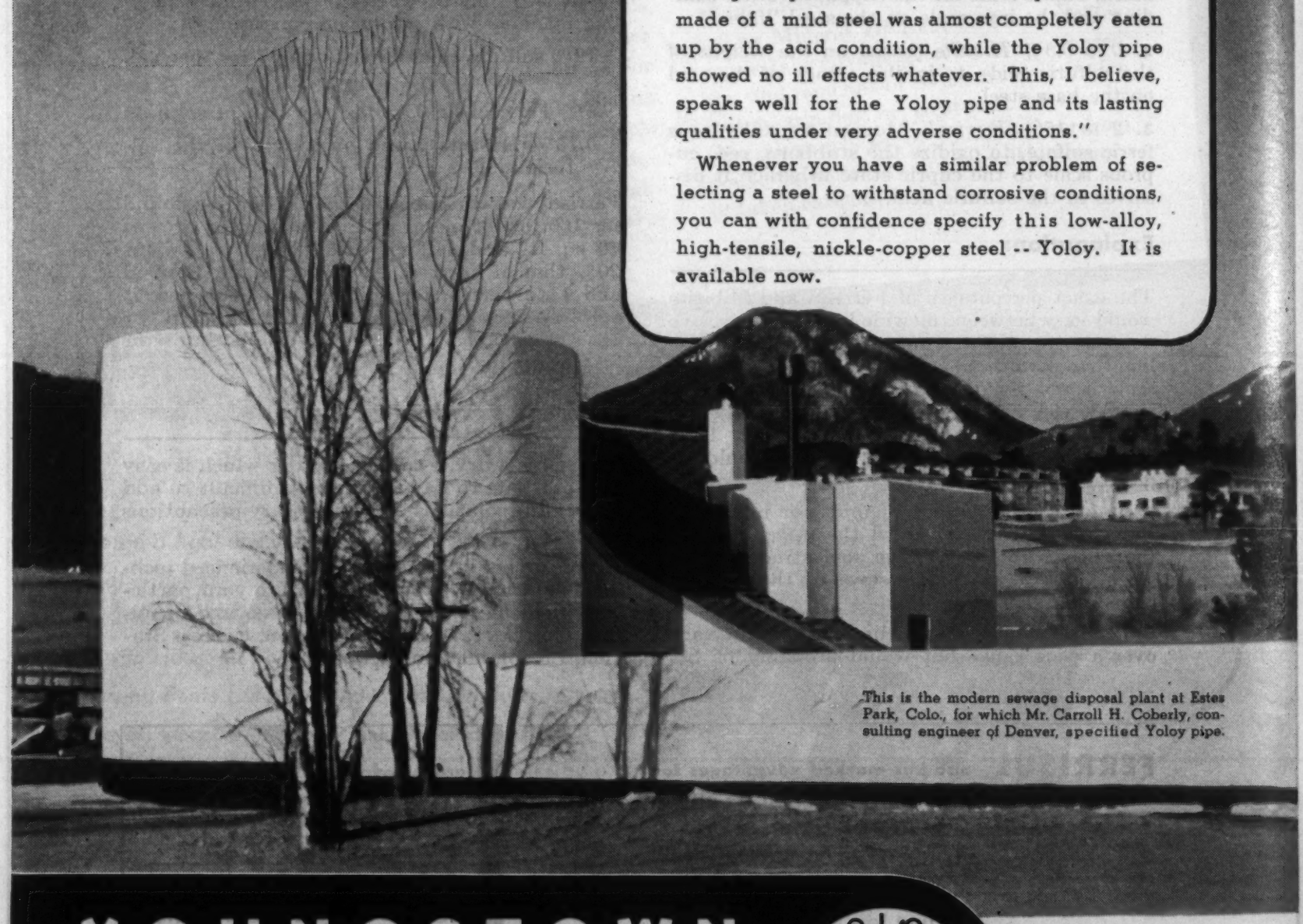
## RESISTS CORROSION

WHEN the Estes Park, Colorado, sewage disposal plant was built, Yoloy pipe was installed to carry the sludge gas from the digestor. Yoloy was selected for this application because of its proven ability to resist corrosion--and it has lived up to its reputation.

Recently it became necessary to make a repair due to a mechanical break in one of the fittings, and the interior of the sludge digestor could conveniently be inspected. The engineer in charge of the project makes this report:

"The Yoloy pipe was supported on a tripod resting on the bottom of the digestor. The city manager reported to me that the tripod which is made of a mild steel was almost completely eaten up by the acid condition, while the Yoloy pipe showed no ill effects whatever. This, I believe, speaks well for the Yoloy pipe and its lasting qualities under very adverse conditions."

Whenever you have a similar problem of selecting a steel to withstand corrosive conditions, you can with confidence specify this low-alloy, high-tensile, nickle-copper steel -- Yoloy. It is available now.



This is the modern sewage disposal plant at Estes Park, Colo., for which Mr. Carroll H. Coberly, consulting engineer of Denver, specified Yoloy pipe.

**YOUNGSTOWN**

**THE YOUNGSTOWN SHEET AND TUBE COMPANY**

YOUNGSTOWN, OHIO

Manufacturers of

CARBON - ALLOY AND YOLOY STEELS

YOLOY TRADE MARK YOUNGSTOWN STEEL

Pipe and Tubular Products - Sheets - Plates - Conduit - Bars - Coke Tin Plate - Electrolytic Tin Plate - Rods - Wire - Nails - Tie Plates and Spikes.

*For long-cycle annealing, normalizing, stress-relieving or hardening of finished or semi-finished material.*

# CAR-TYPE FURNACES *by* SALEM

## ANY SIZE • GAS, OIL, OR ELECTRIC DIRECT FIRED AND RECIRCULATING TYPES BUILT TO YOUR SPECIFICATIONS

Salem can build any size or style of car-type furnace that you may need to facilitate or improve your production. If you have a question as to the most efficient type of furnace for your requirements, we will submit our recommendations based upon broad experience.

Chances are that we will have worked on problems similar to yours because in the past several years, we have been designing and constructing *all* types of industrial furnaces—car, batch, and rotary.

Built to withstand years of hard usage, designed to operate economically, and equipped with proper types of controls, Salem Furnaces will keep your heat treating quality *up* and your cost per piece *down*.

**ANNEALING FORGINGS AND CASTINGS**

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**NORMALIZING STEEL TUBING**

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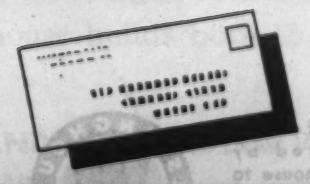
SALEM ENGINEERING COMPANY

**Your inquiry to Salem will receive prompt attention**



# SALEM ENGINEERING CO. · SALEM, OHIO

# GEARMOTORS SAVE SPACE

The gearmotor combines prime mover and speed reducer in a single compact unit. It eliminates the long center-to-center distances of belt drives . . . the space-consuming arrangement of open gearing . . . and the extra floor area required by a separate speed reducer. You can fit a gearmotor up *tight* against the driven machine.

Here's typical example of how gearmotors save space: when a gearmotor replaced the old slow-speed drive on a paper mill calender—*40 square feet of floor space was saved.*

Gearmotors are making equally substantial savings in many other types of applications.

Flexibility in rearranging equipment is another gearmotor advantage. For, in requiring less space, it makes relocation of equipment easier and faster. Ask your Westinghouse representative about this and many other basic gearmotor advantages. All of these are discussed in detail in new book, "Gearmotor Applications". Ask for B-3218. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., Dept. 7-N. J-07218

Second of a series sponsored by Westinghouse to promote the use of gearmotors.

*The New* Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

## 10 GOOD REASONS FOR USING WESTINGHOUSE GEARMOTORS

**1. FEWER PARTS TO WEAR.** The simple, efficient design uses a minimum of moving parts.

**2. BPT "TOUGH-HARD" GEARS AND PINIONS.** This exclusive Westinghouse heat-treating method "tough-hardens" teeth for maximum resistance to shock and impact—means longer wear.

**3. USE ALL WESTINGHOUSE MOTOR TYPES**—open . . . totally-enclosed . . . splashproof . . . explosion-proof —to help meet changes in operating conditions quickly and easily.

**4. INTERCHANGEABILITY OF PARTS** between unit types reduces your parts' replacement stock by 40%.

**5. HIGH EFFICIENCY** of gearing parts assures full motor horsepower at output shaft . . . only 2% power loss per gear set.

**6. POSITIVE LUBRICATION** of gears and bearings by automatic splash system reduces probable maintenance to twice-a-year change of oil.

**7. EASY ACCESSIBILITY.** Gearing parts can be readily inspected or easily removed to effect gear ratio changes.

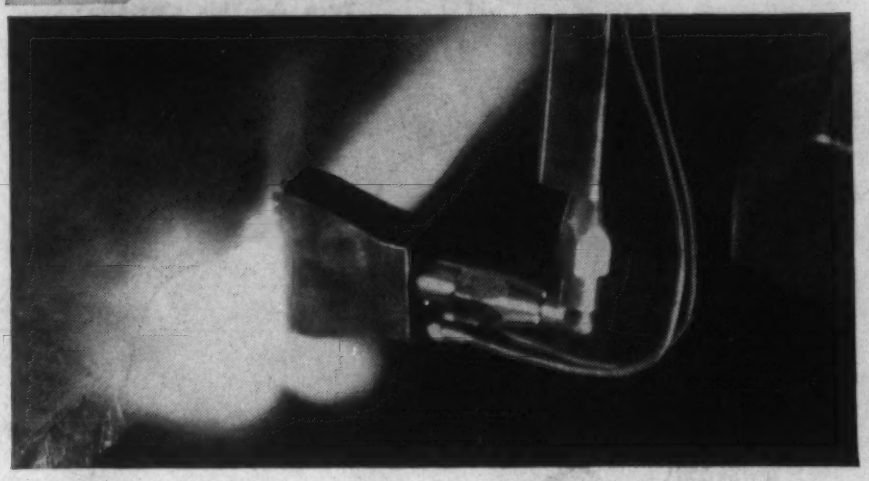
**8. IMPROVED FOUNDATION STABILITY.** Feet are under the gear case . . . placing support next to the gearmotor load. Each foot is reinforced by external ribs.

**9. UNIT RESPONSIBILITY** for design . . . manufacture . . . and service. Westinghouse builds both the motor and the gears.

**10. MEET A.G.M.A. STANDARDS.** The new Westinghouse Gearmotors are specifically designed and built to meet A.G.M.A. standards . . . easy to order and match to the job.

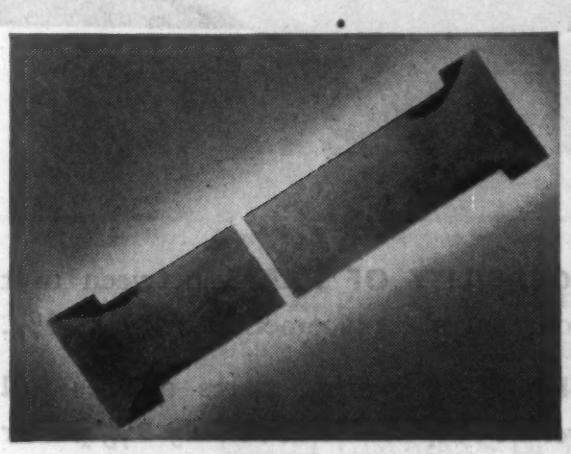
# Gearmotors

# These LINDE Processes For Treating Metals *Save Time and Materials*

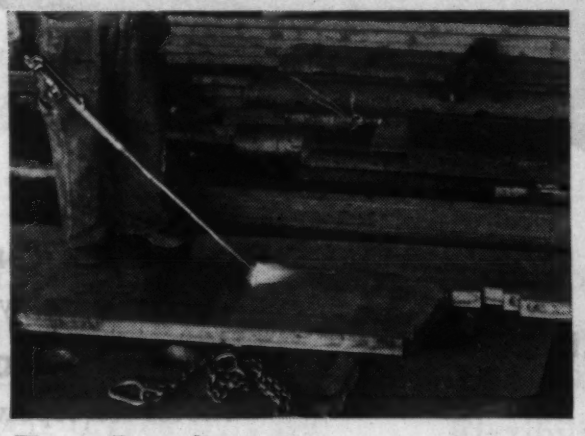


***Flame-Softening*** — This oxy-acetylene process is used to soften metal which has become hardened so as to facilitate subsequent machining. It is generally used in connection with the flame-cutting of air-hardening steels, and also for such work as the local refining of weld passes, or for softening flame-cut riser pads on castings.

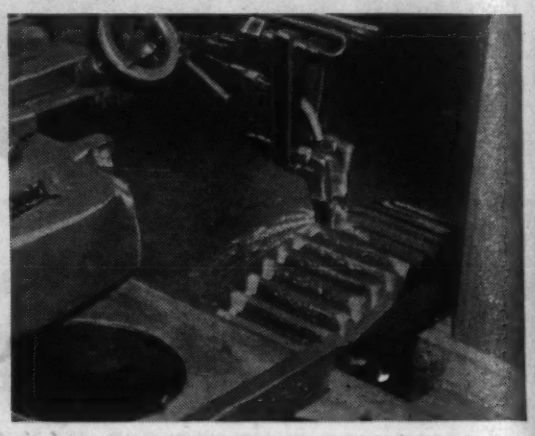
***Flame-Priming*** — The quick heat of oxy-acetylene flames — when passed over steel prior to painting — breaks off loose scale, drives off moisture, and renders rust passive so that it can be brushed away. If the surface is then wire-brushed, and paint applied while the metal is warm and dry, the paint goes on rapidly, dries quickly, and bonds tightly.



***Flame-Strengthening*** — This process is used to strengthen locally high-stressed parts. Shown here is a macroetch of failed fatigue-test specimen. The black areas have been flame-strengthened.



***Flame-Descaling*** — This oxy-acetylene method is similar in application to flame-priming, and is used where it is desired to remove practically all of the encrustations on steel. It successfully removes mill scale, rust, and electric weld flux.



***Flame-Hardening*** — This method utilizes the intense, easily-controlled heat of oxy-acetylene flames, and a water or oil quench, to impart a hard case to steel and iron parts to make them last longer.

**The Linde Air Products Company**

*Unit of Union Carbide and Carbon Corporation*

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"The words "Linde," "Prest-O-Lite," "Union," "Oxweld," "Purox," and "Prest-O-Weld" are trade-marks.

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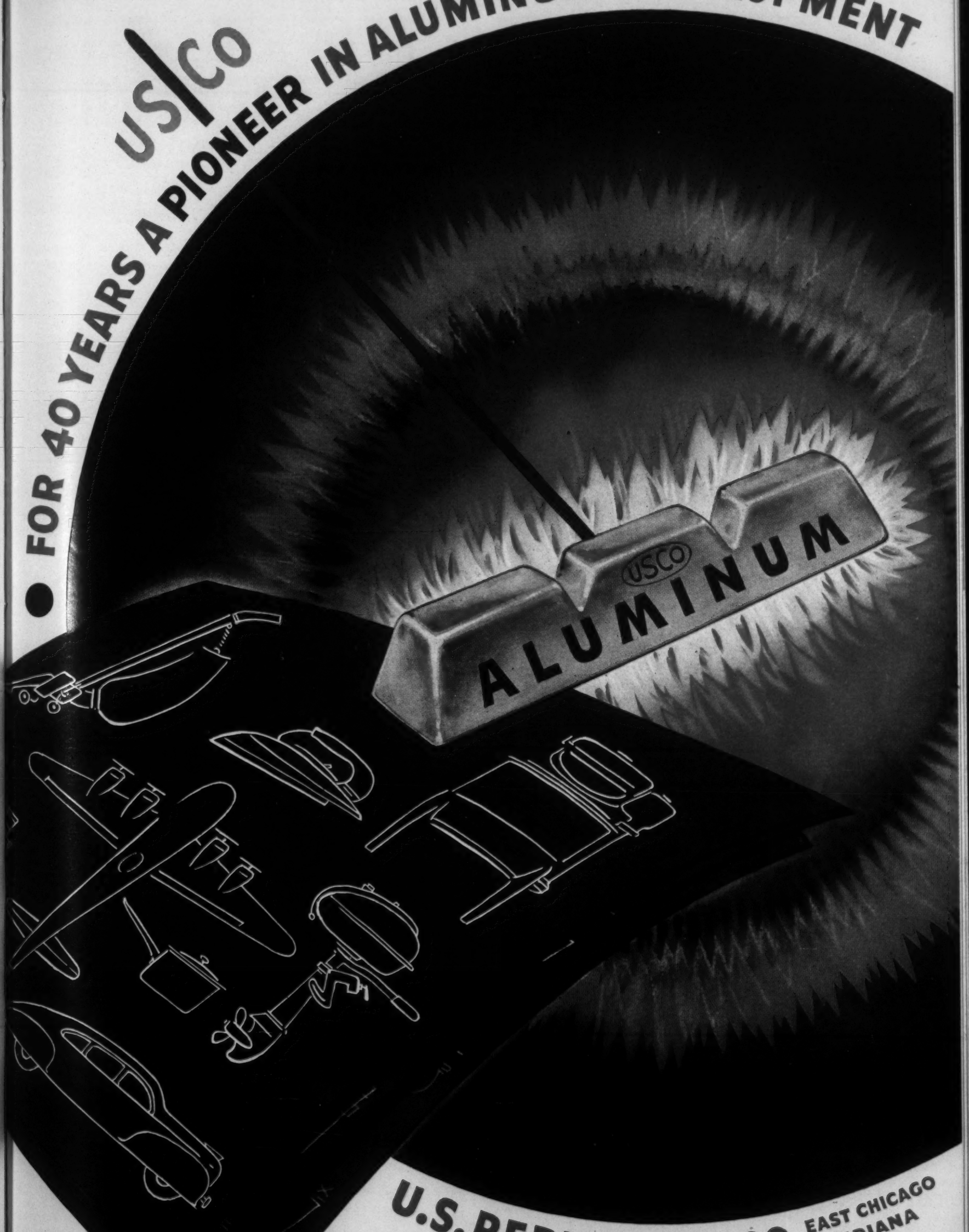


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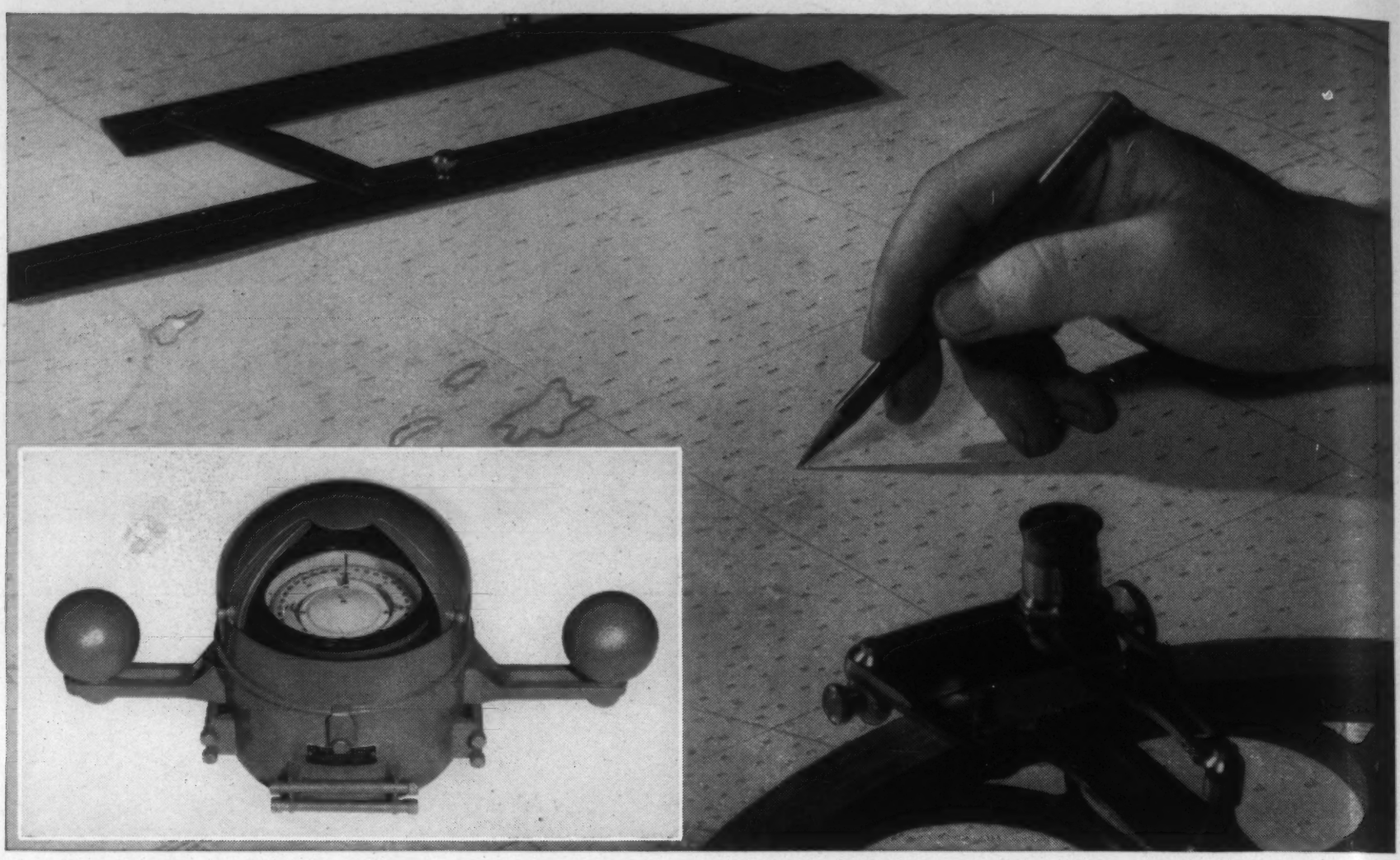

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Modern compasses are versions of the earliest known application of permanent magnets. Today the hundreds of uses for permanent magnets are widely diversified and are expanding rapidly through aggressive engineering and research.

34 years of specialized experience in this field have enabled us to play a leading role in developing these new uses. Our large, modern plant is one of the nation's vital sources of supply.

Write us, on your letterhead, for the address of our office nearest you and a copy of our "Permanent Magnet Manual" containing valuable data.

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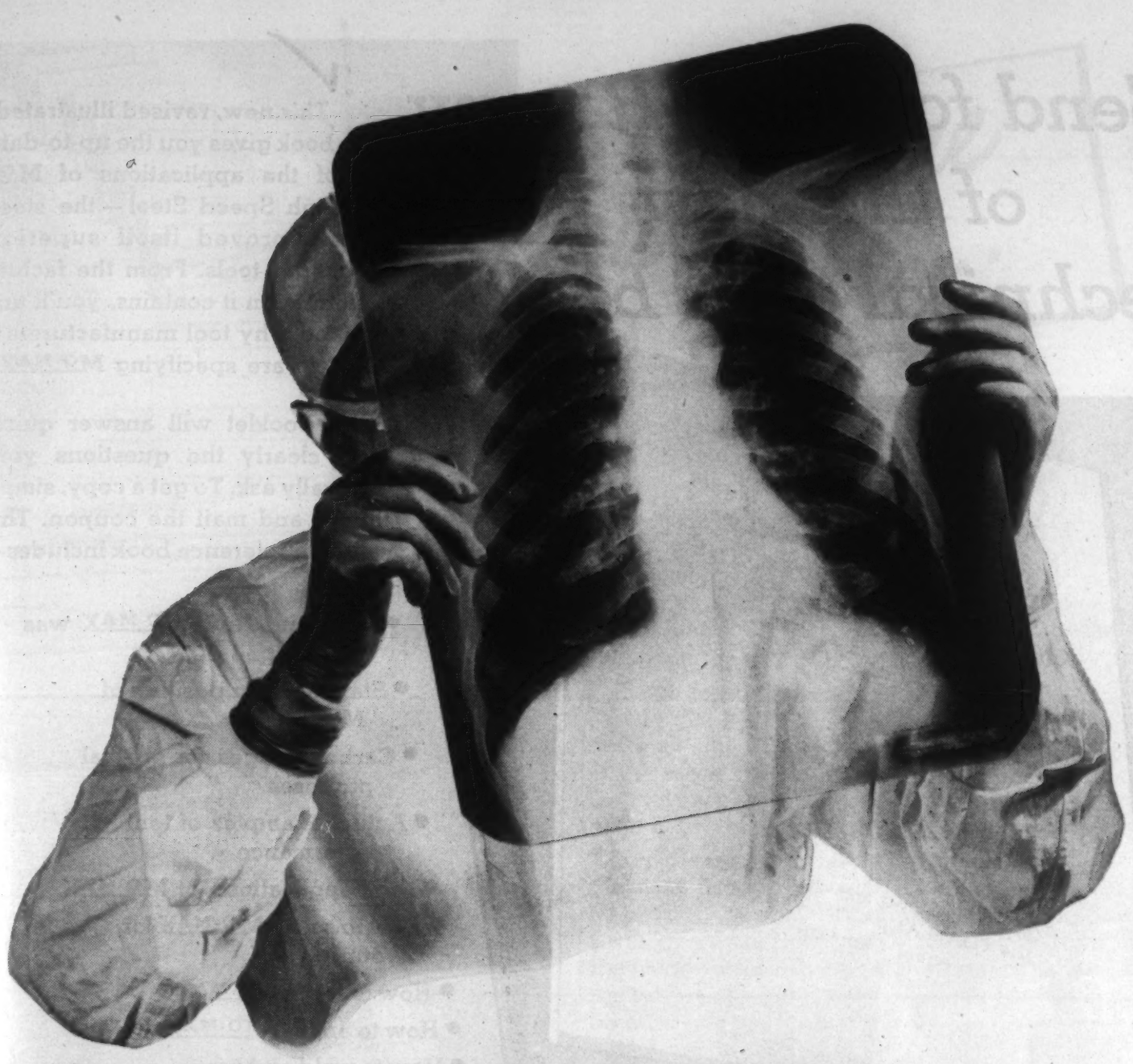

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## ...handle with care!

Many a wounded hero will come home well and strong again, thanks to a thin sheet of film...

Thanks to the miracle of the X-Ray . . .

And thanks to air conditioning and refrigeration which help make the miracle possible! *Air conditioning* supplies clean, filtered air—with accurate regulation of both temperature and humidity—in plants where X-Ray film is made, in army hospitals where it is used. *Refrigeration* cools the solutions used in processing the film.

Out of such wartime applications, General Electric is evolving new techniques, finer equipment for conditioning temperature and humidity. When equipment again is available for peacetime commercial and industrial uses, it will be vastly improved—more compact, more efficient, more flexible than ever before!

*Now* . . . we'll be glad to put your name down for *earliest available* data on postwar air conditioning and refrigeration equipment. Write: *General Electric Co., Air Conditioning and Commercial Refrigeration Divisions, Section 426, Bloomfield, N. J.*

☆ BUY WAR BONDS ☆

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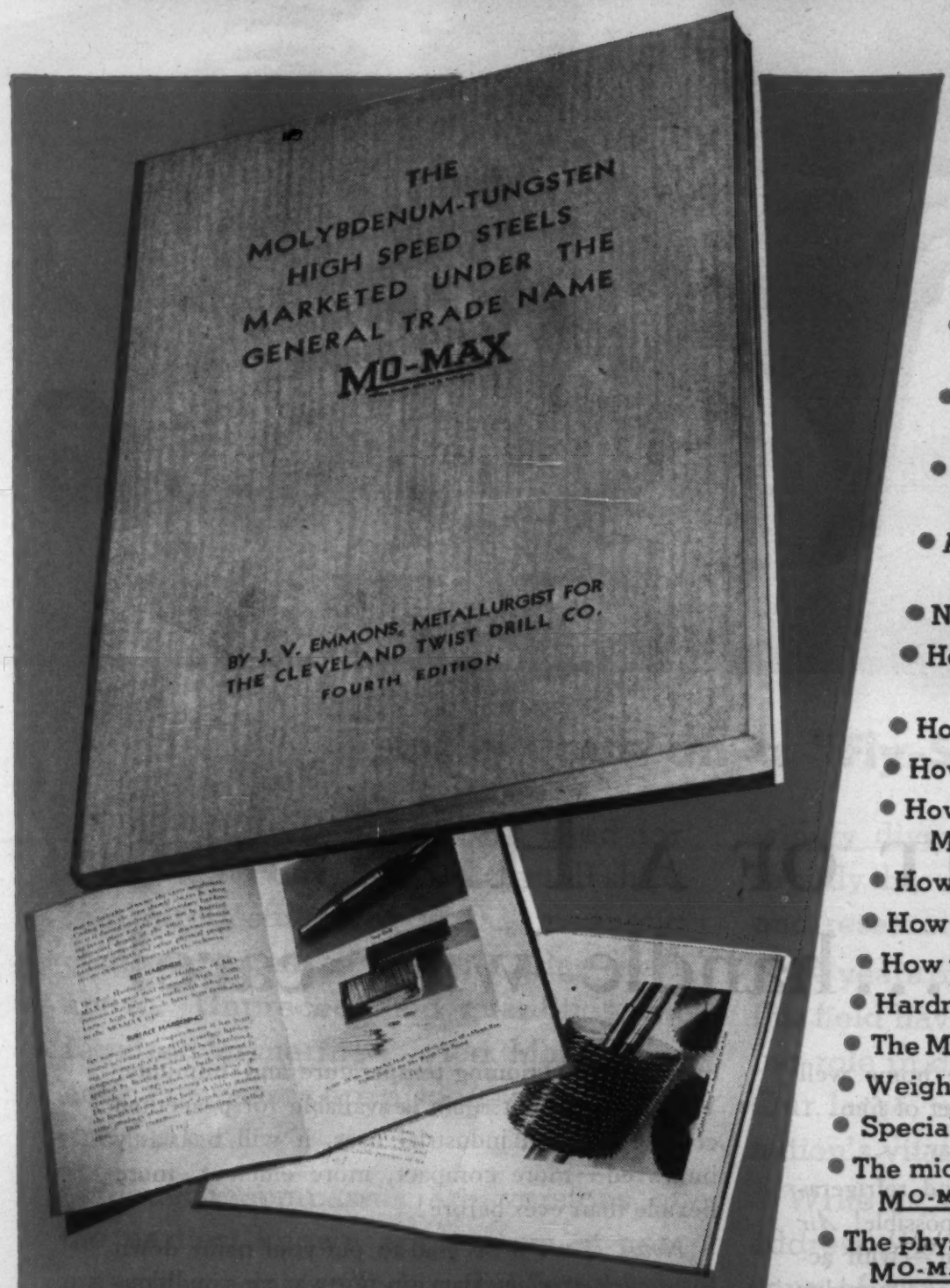
# *Send for YOUR copy of this new technical data book!*




This new, revised illustrated handbook gives you the up-to-date story of the applications of MO-MAX High Speed Steel — the steel that has proved itself superior for cutting tools. From the factual information it contains, you'll understand why tool manufacturers and others are specifying MO-MAX.

This booklet will answer quickly and clearly the questions you'll naturally ask. To get a copy, simply fill out and mail the coupon. This valuable reference book includes—

- Why and How MO-MAX was developed
- Standard composition of MO-MAX
- Carbon ranges for special purposes
- Actual examples of tool performance
- New applications of MO-MAX
- How to select MO-MAX for your job
- How to forge MO-MAX
- How to anneal MO-MAX
- How to weld and braze MO-MAX
- How to heat treat MO-MAX
- How to quench MO-MAX
- How to temper MO-MAX
- Hardness of MO-MAX
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- Weight economy of MO-MAX
- Special MO-MAX compositions
- The microstructures of MO-MAX
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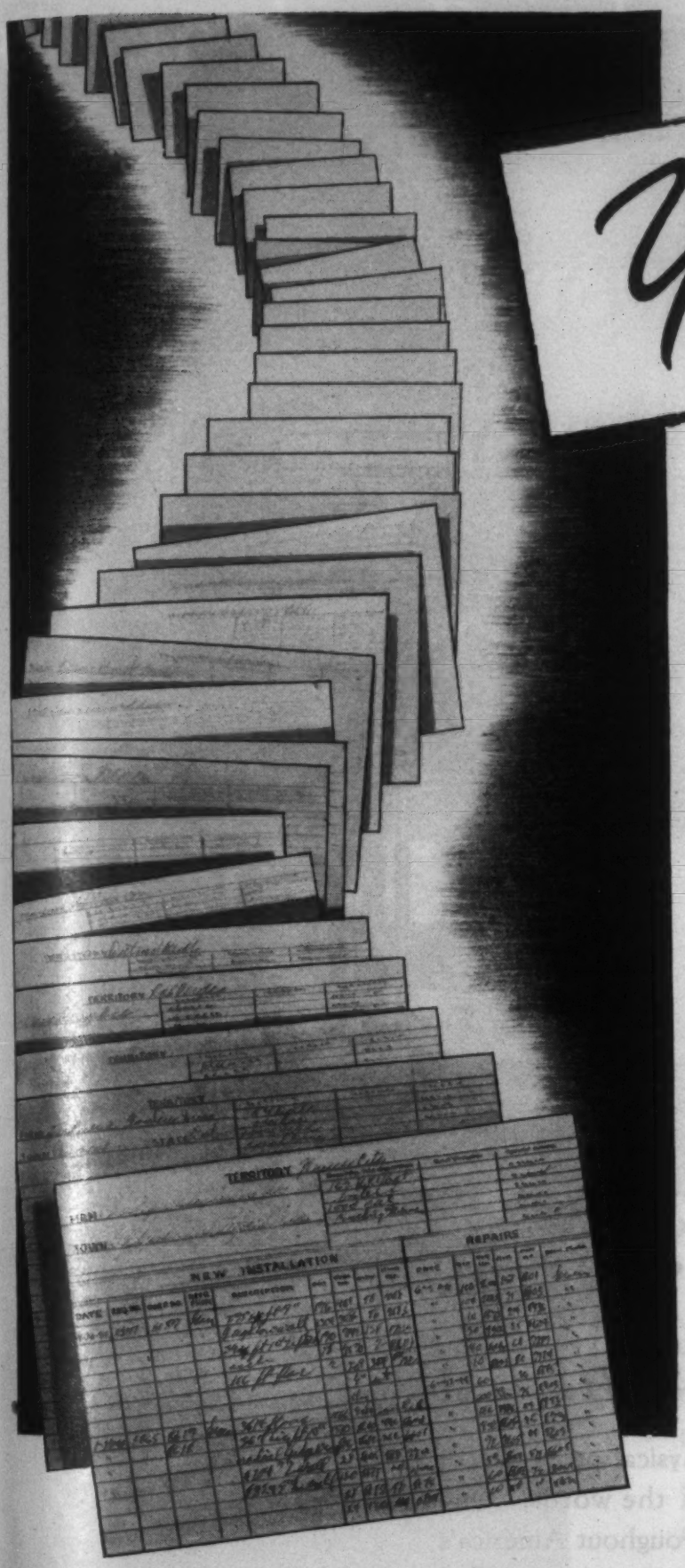
| "Star Max" | Carpenter Steel Co. | "S. T. M." | Simonds Saw and Steel Co. |
| "Molite 8" | Columbia Tool Steel Company | "Mo-Tung" | Universal-Cyclops Steel Corp. |
| "Rex-T-Mo" | Crucible Steel Co. of America | "Vul-Mo" | Vulcan Crucible Steel Co. |




# Your Name Here...*

## *may save you money and invaluable time*

When industrial furnace enclosure repairs become necessary today, there's a lot of satisfaction in knowing that they can be made efficiently — and quickly — under the supervision of the company which designed those enclosures.

If you are fortunate enough to have Bigelow-Liptak furnace enclosures in your plant—the entire record of the installation; its description and lists of all repair parts are at the finger tips of our production department—ready to be used at a moment's call to help you get your furnace back in efficient operation in a minimum of time.

Experiences like the recent predicament of one of the major oil refineries prove the value of this Bigelow-Liptak feature. By means of comprehensive Trade Cards — that cover every Bigelow-Liptak installation from one end of the world to the other—recommendations were made over the telephone to this refinery which was having difficulties because war production during the last several years had forced operation to almost double its designed capacity. Necessary repair parts were indicated. A fully informed engineer was rushed to the job. And this aviation gasoline plant which had operated five years without repairs was back in service in four days at this greatly increased rating.

**"Please accept our appreciation for the effort made to put this plant back in operation. It is nice to know we are dealing with companies and individuals who feel an interest and a responsibility in the jobs they have furnished,"** wrote the chief engineer of this great refinery. This is but one of dozens of recent tributes paid to the cooperation, engineering skill and efficient organization of Bigelow-Liptak.

Your operation may depend not only on the design of the heat enclosure but the cooperation and efficient organization that backs it up.

It will pay you to discuss your heat enclosure problem with Bigelow-Liptak — if you want enclosures that will give service and economy over a long continuous operating period. Get in touch with a Bigelow-Liptak engineer.

***In the general office of Bigelow-Liptak** *there is a Trade Card that contains a detailed record of every installation. On this card will be found all of the data and information necessary and useful in servicing the job. Many of these cards are never referred to because Bigelow-Liptak enclosures are designed for long dependable service. But since furnace enclosures are the parts most subject to wear and tear, these records often become life savers for our customers.*

*When emergencies come we can quickly refer to any customer's Trade Card and find an accurate record of any installation. In a few minutes, with the aid of this information, we can set in motion the work that will enable him to get his furnace back in service in a minimum of time. Your name on a Bigelow-Liptak Trade Card may save you money and invaluable time.*

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*Unit-Suspended Walls & Arches*

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*A Unit-Suspended Wall & Arch for Every Furnace*

"One test is worth a thousand expert opinions"

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*Pendulum load indication is more accurate and dependable because it operates on the natural laws of gravitation. This principle of operation is not affected by temperature changes or subject to metal fatigue.*

# *Precision*

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. . . . have simplified the science of testing the physical properties of materials and substantiated the accuracy in results in the words, "One Test is Worth a Thousand Expert Opinions". Today, throughout America's wartime industries, Riehle Testing Machines are ferreting out material weaknesses and defects; avoiding failures before they occur. This technique of progressive testing on the production line and research saves valuable machine and man-hours. Write for descriptive literature and quotations.

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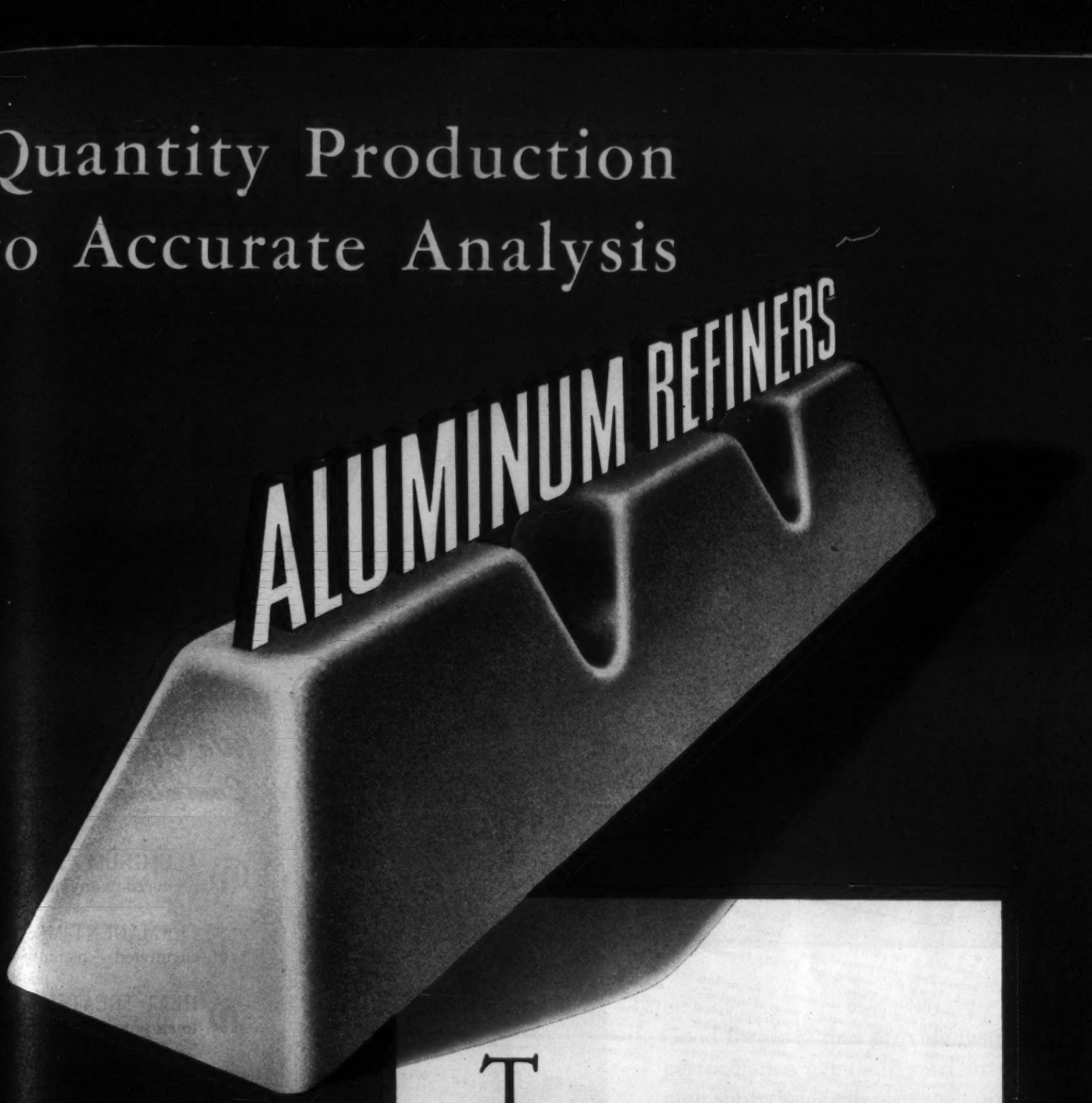
# Quantity Production to Accurate Analysis




The fact that Aluminum Refiners is a quantity producer of Aluminum Alloy Ingot means also that we are a quality producer. For our volume is such that we are enabled to use the finest and newest equipment—install the most elaborate production and laboratory checks and tests. Consider Aluminum Refiners as your source of supply for Aluminum Alloy Ingot—combining both quality and quantity production.

## ALUMINUM REFINERS

*Division of*

**BOHN ALUMINUM & BRASS CORPORATION • Detroit 26, Michigan**

*General Offices Lafayette Building*

MANUFACTURERS OF ALL TYPES AND SHAPES OF CASTING AND DEOXIDIZING ALLOYS

# Sensational New Product

## The PESCO PRESSURE LOADED HYDRAULIC PUMP

★ It weighs less than 4 pounds. It's so compact you can hold it in the palm of your hand. But it delivers enough pressurized power to lift a General Sherman tank. That's the amazing, new PESCO Pressure-Loaded Hydraulic Pump!

Never, until PESCO engineered it for modern aviation, was there so small a pump of equal displacement capable of delivering 3000 p.s.i. Radical improvements in design plus precision manufacture of the highest order are the ingredients.

Through PESCO design, entirely new opportunities are opened up for the more practical and efficient use of hydraulics in your product or plant. And that goes for controlled liquid flow as well as pressurized power. For PESCO's advanced design and performance extends through a complete line of hydraulic, pneumatic, vacuum and fuel pumps and pumping systems. Practically without exception, the precision equipment PESCO makes has been engineered to specifications of performance never dreamed of before modern aviation.

We would welcome the opportunity to tell you of our facilities to engineer PESCO equipment to meet your own specific problem. PESCO Engineering Service is available to you. Just write.

**SEND FOR THIS BOOK** "Pressurized Power and Controlled Flow by PESCO". This book pictorially tells the story of PESCO equipment, manufacturing facilities and engineering service. A copy will be mailed promptly upon request.

**WRITE TO...**
PESCO Products Co.
Industry Service F
11610 Euclid Avenue
Cleveland 6, Ohio

Division Borg-Warner

In Precision Hydraulics, Fuel Pumps, Air Pumps, Related Accessories . . . PERFORMANCE POINTS TO Pesco FIRST

## IS OF

## NATIONAL PERMANENT MOLD ALUMINUM CASTINGS

*We Offer You A Complete Service*

- ALUMINUM CASTINGS produced in any quantities.
- PERMANENT MOLDS engineered — manufactured
- HEAT TREATED to all specifications
- RIGID CONTROLS x-ray inspection, etc.
- DELIVERIES all quantities and schedules

Our Engineering Department will assist in your post war requirements . . . developing or adapting the use of PERMANENT MOLD ALUMINUM CASTINGS.

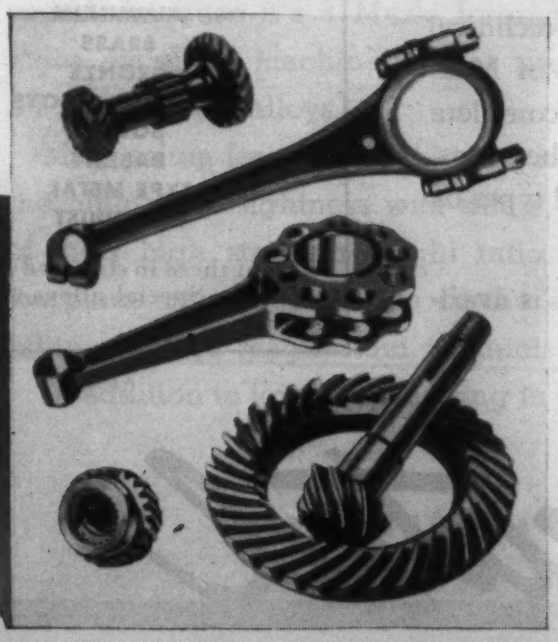
WRITE US FOR FULL INFORMATION.

# NATIONAL ALUMINUM MFG. CO., PEORIA, ILL.

**CHICAGO, 1424-A Merchandise Mart. DETROIT, 8-254 Gen. Motors Bldg. BUFFALO, 837 Potomac St.**

# THE Quality OF FORGINGS

## STARTS IN THE MELT SHOP



Good forgings that provide lasting performance get their start in the melt shop. Regardless of the equipment used, flawless forgings can only be produced when they are made from steel that possesses a combination of strength and toughness with freedom from internal defects. Timken alloy steels of open hearth or electric furnace grades more than meet these qualifications.

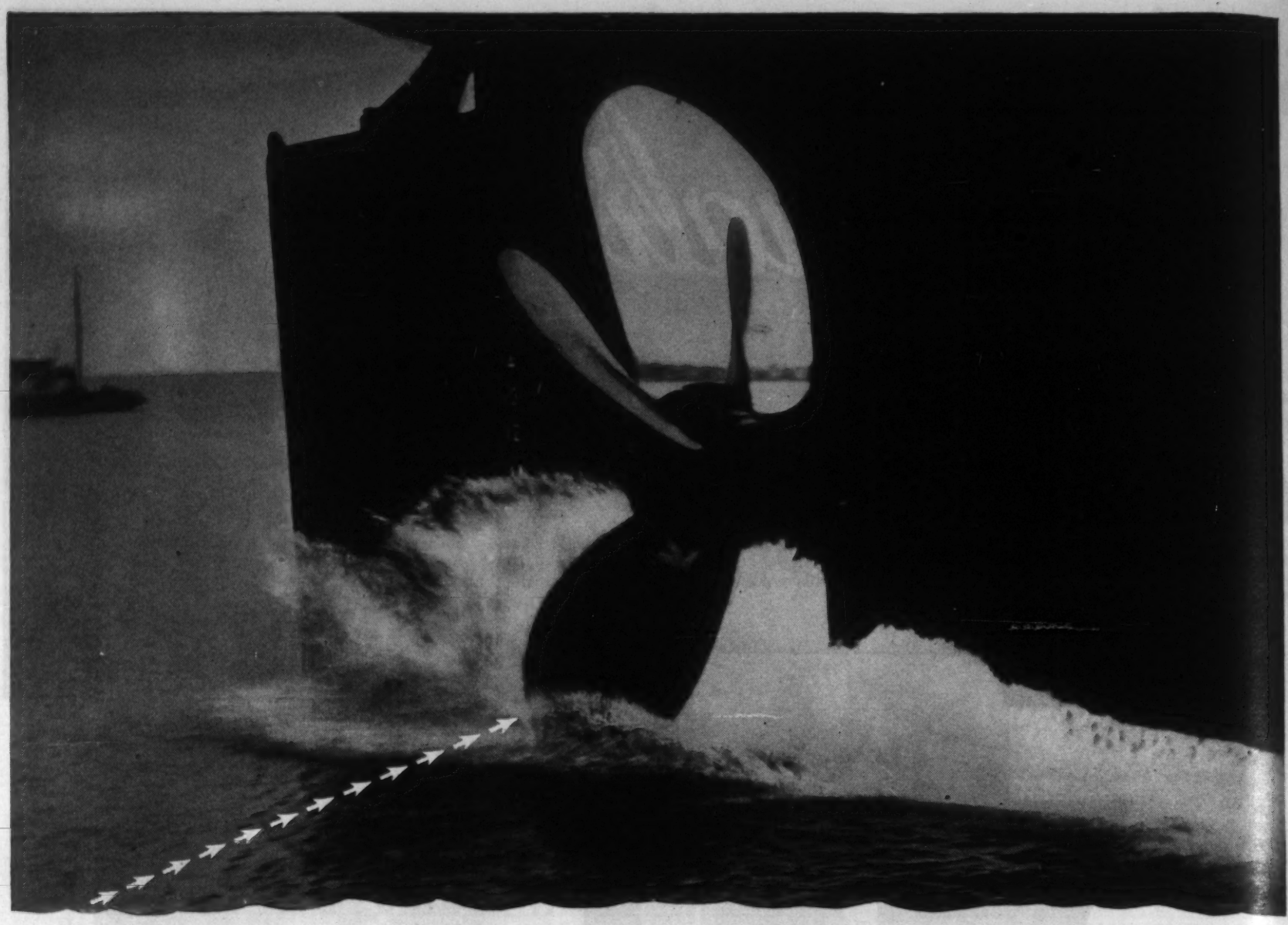
The high uniform quality of performance-proven Timken alloy steels are the results of careful control measures that provide steels of exact analyses, with uniform grain size, free from injurious segregations and possessed of the correct physical properties. Every one of these qualities is necessary to produce forgings that will provide dependable performance.

Plan to use Timken alloy steel for your Post War products. Their use will mean increased production and greater profits. Steel and Tube Division, The Timken Roller Bearing Company, Canton 6, Ohio.

**TIMKEN**

TRADE-MARK REG. U. S. PAT. OFF.

**ALLOY STEELS**



# This is the end that ought to get the champagne!

The propeller deserves a little of the champagne and a little of the cheering too, because it is the ship propellers that push the men and materials for war across both oceans to the battle zones.

Thanks to careful treatment of material and advances in technical control of processes, Federated is furnishing ever-increasing amounts of Manganese Bronze to America's shipbuilders for use in manufacturing complete propellers, propeller blades, rudder fittings, stuffing boxes, stern tube bearings, and propeller blade bolts. Federated can meet your requirements for all types of Bronzes. Consult the Federated office nearest you.

A new booklet "Some Considerations in Making Test Bars" is available. Write today for Booklet T– 12

INGOT METALS AND WHITE METAL ALLOYS PRODUCED BY FEDERATED

**ALUMINUM**
**BRASS**
**BRONZE**
**DIE CAST ALLOYS**
**SOLDER**
**BABBITT**
**TYPE METAL**
**ZINC DUST**

All of these in standard specifications. Special alloys to your order.

**FMD**

*Federated*

METALS DIVISION

**AMERICAN SMELTING and REFINING COMPANY**

120 BROADWAY, NEW YORK (5) N. Y.

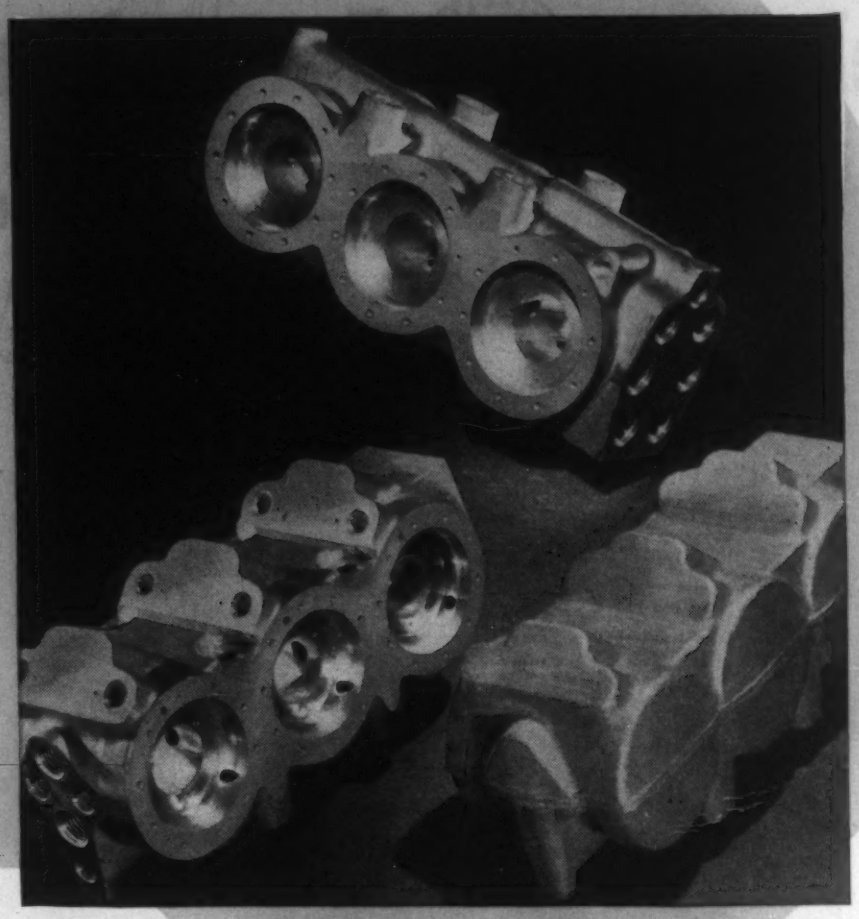
Nation-wide service with offices in principal cities

# FORGED

*for soundness*

# MAGNESIUM

*for light weight*



Typical of many wartime products of American Magnesium Corporation is this forging, machined as you see it here into a part for an automatic pilot. It is very light in weight, magnesium's outstanding characteristic. It is sound, because it's a Mazlo forging. It provides excellent machinability, a property of all magnesium alloys.

Magnesium forgings enable you to achieve the ultimate in lightness with safety, because of their high strength-weight ratio. Many a warplane carries evidence of the dependability of these magnesium products.

In addition to forgings, ranging in size from tiny pieces to those weighing many pounds, American Magnesium is producing magnesium alloy products in all other forms; sand castings, permanent mold and die castings, screw machine products, shapes and sheet. More than twenty years of experience in fabricating magnesium goes into these dependable products.

If you are wondering about ways of utilizing the weight-saving ability of magnesium alloys to best advantage, our engineers will gladly assist you. Write Aluminum Company of America, Sales Agent for Mazlo Magnesium Products, 1710 Gulf Bldg., Pittsburgh 19, Pa.

MAGNESIUM MAZLO PRODUCTS

REG. U.S. PAT. OFF.

# AMERICAN MAGNESIUM CORPORATION

SUBSIDIARY OF ALUMINUM COMPANY OF AMERICA

FOR VALVE TRIM AND WEARING PARTS...INVESTIGATE THESE

# Lebanon (L) Corrosion Resistant Alloys

## WITH DIFFERENTIAL HARDNESS

Poppet valve discs for regulating valves

Wedges for gate valves

Seats for globe valves

Double disc for double seated valve

Wedges for gate valves

SERVICE conditions should be carefully studied in specifying alloy steels for valve trim and the wearing parts of valves. Lebanon (L)12 and Lebanon (L)13 were developed to meet the following service conditions considered in relation to corrosion resistance:

1. Replaceability.
2. Freedom from galling and seizing in valves where a sliding action between disc and seat is unavoidable.
3. The wire drawing effect where valves subject either to high temperature or high pressure, or both, are operated in "slightly opened" or "just cracked" position.
4. The form of the trim . . . the machining necessary . . . the hardness conditions best suited to machining . . . the ultimate hardness best suited to function.

### Qualities of Lebanon (L)12 and Lebanon (L)13

**LEBANON (L)12—A 13% CHROME (approx.), .15 CARBON (max.) ALLOY.** ***With suitable heat treatment, a Brinell Hardness of about 200 to 375 can be obtained.***

**LEBANON (L)13—A 13% CHROME (approx.), .25 CARBON ALLOY to which other elements are added to produce higher hardness than can be had in Lebanon (L) 12.** ***With suitable heat treatment, a Brinell Hardness of about 225 to 500 can be obtained.***

For both Lebanon (L)12 and (L)13, heat treatment selected and resulting hardness depend on service application. Castings of either can be heat treated at the foundry or by the user.

These alloys may be specified for valve trim and wearing parts of valves over a wide range of corrosive actions. They satisfactorily resist alcohol, ammonia, bleach, many fruit juices, lubricating, steam, soap, lye, vegetables, fresh water, vinegar and many organic chemicals.

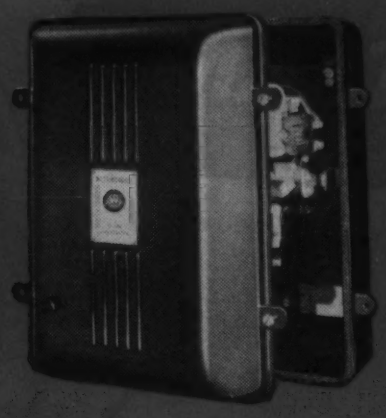
Where corrosion of a special character is encountered, it is suggested that specific study of the problem be made. Write to Lebanon outlining the condition. Or request an interview with a Lebanon metallurgist or foundry engineer.

**LEBANON STEEL FOUNDRY LEBANON, PA.**

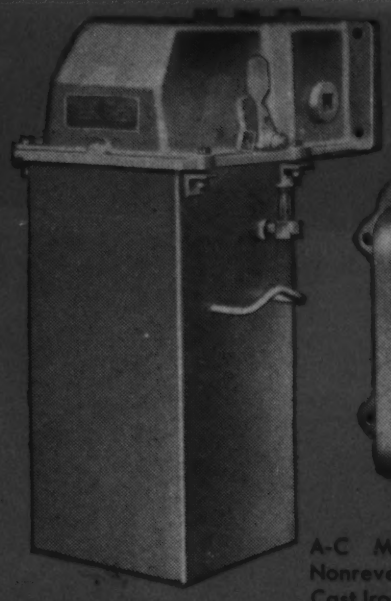
ORIGINAL AMERICAN LICENSEE GEORGE FISCHER (SWISS CHAMOTTE) METHOD

**LEBANON (L) *Alloy and Steel* CASTINGS**

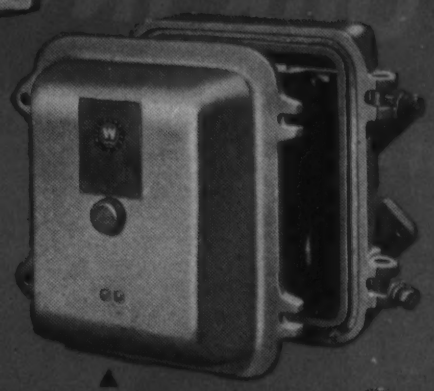
A-C Magnetic "De-ion" Nonreversing Linestarter; Standard Sheet Steel Enclosure.



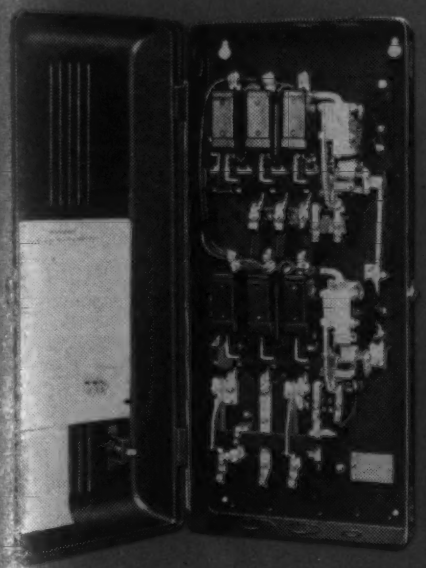
A-C Magnetic "De-ion" Nonreversing Linestarter; Gasketed Dust-Tight Sheet Steel Enclosure.



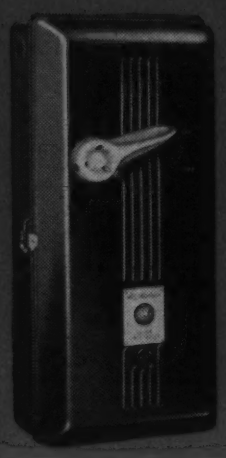
Oil-Immersed "De-ion" Linestarter for Squirrel-Cage Motors for Class I, Group D Hazardous Locations.



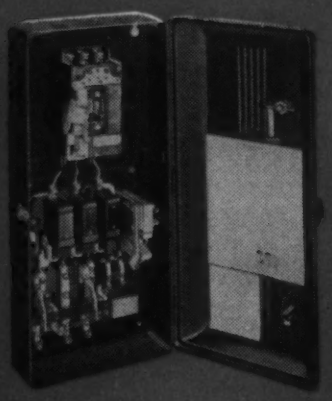
A-C Magnetic "De-ion" Nonreversing Linestarter; Cast Iron with Ground Surfaces between Cover and Case—for Class II, Groups E, F and G Hazardous Locations.



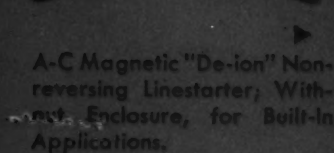
A-C Magnetic "De-ion" Reversing Linestarter for Squirrel-Cage Induction Motors; Standard Sheet Steel Enclosure.



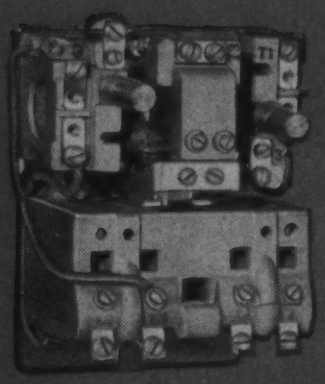
A-C Magnetic "De-ion" Combination Nonreversing Linestarter with Fusible Motor Circuit Switch; Standard Sheet Steel Enclosure.



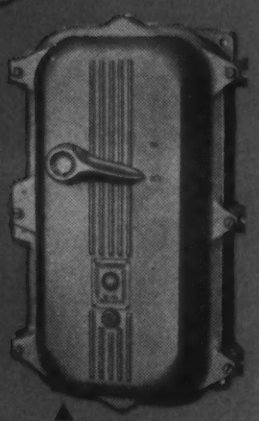
A-C Magnetic "De-ion" Combination Nonreversing Linestarter with Non-Fusible Motor Circuit Switch; Standard Sheet Steel Enclosure.



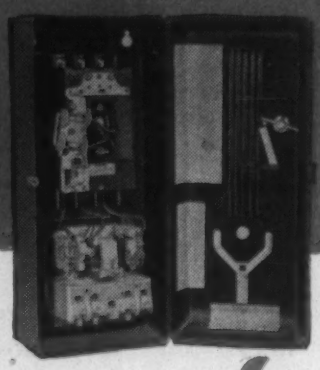
A-C Magnetic "De-ion" Nonreversing Linestarter; Without Enclosure, for Built-In Applications.



A-C Magnetic "De-ion" Combination Nonreversing Linestarter with AB Nofuze Circuit Breaker; Standard Sheet Steel Enclosure.



A-C Magnetic "De-ion" Combination Nonreversing Linestarter with Non-Fusible Motor Circuit Switch; Water and Dust-Tight Cast-Iron Enclosure.



# WHEN YOU NEED *Magnetic Controls*

## FOR SINGLE-PHASE AND SQUIRREL-CAGE MOTORS CONSULT WESTINGHOUSE BUYING DATA (NEW CATALOG 7000)

With the new Westinghouse Buying Data, you can select and purchase the proper motor control in half the time.

Data, as presented, is striking in its newness. It's easier to read, easier to understand, and easier to use than any published previously by any manufacturer.

Chances are—if you are a buyer of motors and controls—that you have already received a copy of this new Catalog 7000 by mail. However, if you have not received your copy, write, wire or phone your nearest Westinghouse district office. (Requests will be filled through district offices only — no mailing from Westinghouse headquarters at East Pittsburgh.) J-60552

**Westinghouse**
PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

*De-ion Linestarters*

# OUR INVASION TEAM

*Official U. S. Marine Corps News Photo by Acme*

When G. I. Joe hits the invasion beach, much of his equipment . . . from landing barges and motorized equipment that spearhead his advance, to planes that form a protective canopy over him . . . will have component parts made from aluminum alloys. And back of our invading soldiers stand the home-front workers whose conservation of aluminum scrap collected in manufacturing processes and kept carefully segregated, insures adequate supplies of these war-vital alloys.

But this teamwork would be incomplete without the teamwork in the smelters' own plants . . . teamwork that insures these new alloys meeting rigid quality specifications. By means of close cooperation between the laboratories and the production department it is possible to re-alloy this aluminum scrap into closely controlled ingot of proven quality.

This same controlled quality will benefit foundries postwar . . . enabling them to make better castings at minimum cost for better civilian products.

Aluminum and Magnesium, Inc.
*Sandusky, Ohio*

The American Metal Company, Limited
*New York City 6*

Apex Smelting Co.
*Chicago 12, Illinois*

The Cleveland Electro Metals Co.
*Cleveland 13, Ohio*

Federated Metals Division American Smelting and Refining Company
*New York City 5 and Branches*

General Smelting Company
*Philadelphia 34, Pennsylvania*

Samuel Greenfield Co., Inc.
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William F. Jobbins, Inc.
*Aurora, Illinois*

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The National Smelting Company
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Niagara Falls Smelting & Refining Corp.
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## ALUMINUM RESEARCH INSTITUTE

111 West Washington Street, Chicago 2, Illinois

BUY BONDS

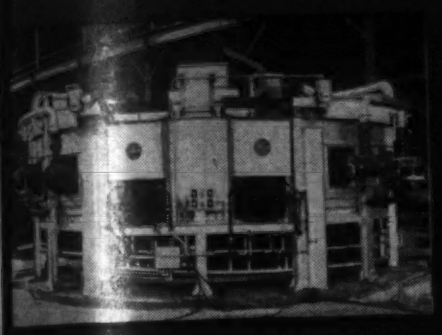
# Setting New Production Peaks

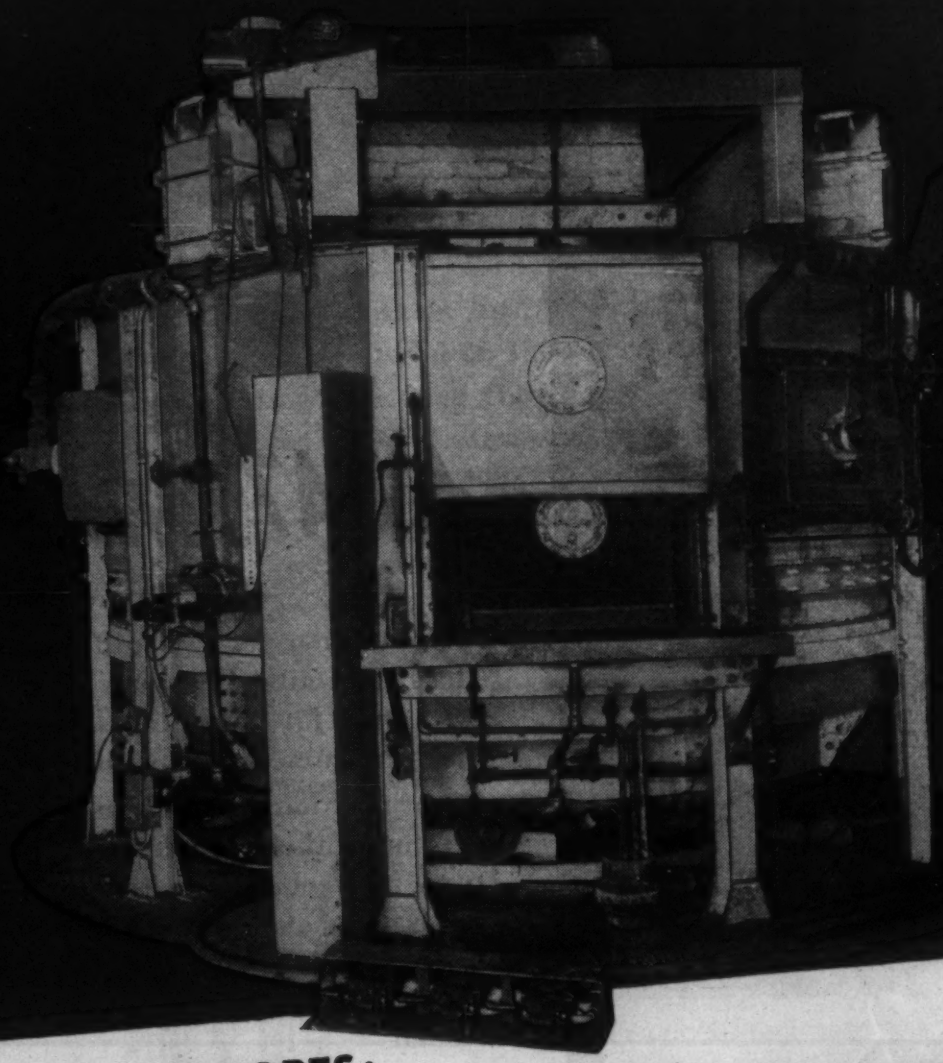
## IN AMERICA'S FORGE PLANTS!

# Hagan

ROTARY HEARTH

# FURNACES





## ONE PLANT REPORTS:

## "OVER 30,000 FORGINGS WITHOUT A REJECTION"

Production records like this mean just one thing—HAGAN Rotary Hearth Forging Furnaces have what it takes to do the job better—more economically.

HAGAN Rotary Hearth Furnaces give completely accurate control of heating time and temperature thus providing uniformly heated billets at the desired forging temperature. Burned or cold steel is eliminated,—metal losses are greatly reduced.

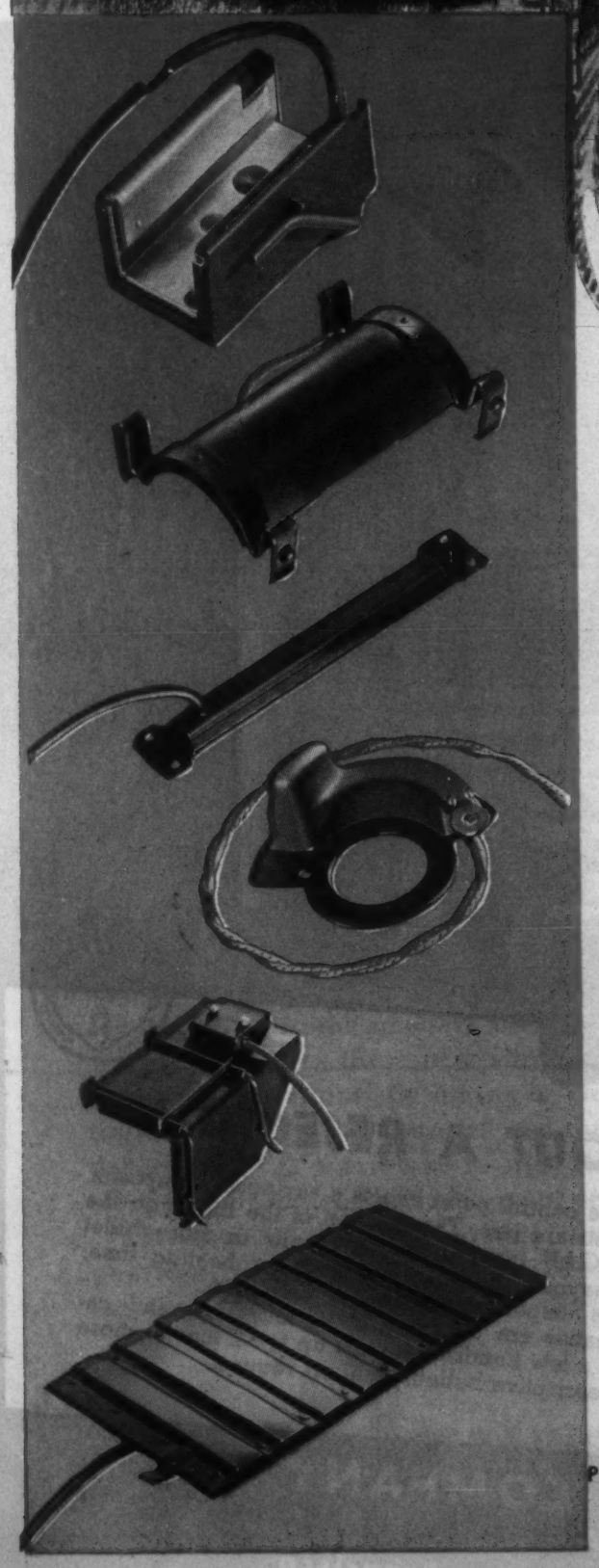
The HAGAN method of charging and discharging the furnace at one central point effects a saving in manpower and labor costs are less. The position of the billets on the patented HAGAN furnace hearth results in more billet area being exposed to heat, hence faster heating time, lower furnace temperature and lower fuel costs.

These furnaces are available in various sizes and capacities from a few hundred pounds up to 12 tons or more per hour. Descriptive bulletin sent on request.

## GEORGE J. HAGAN COMPANY

PITTSBURGH, PA.

Detroit · Chicago · Los Angeles · San Francisco



## WE KNOW HOW TO PUT *HEAT where you need it*

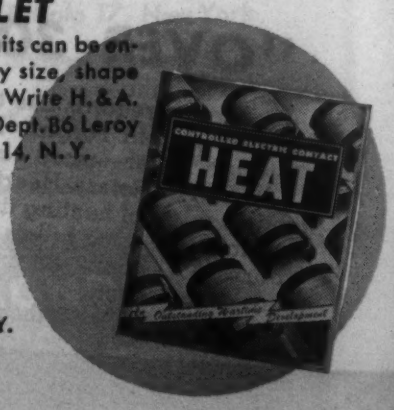
● Shown here are six different shapes of H. & A. Electric Contact Heat Units. Each was especially engineered to do a specific job. One, for example, is keeping hundreds of thousands of machine guns firing in sub-zero temperatures.

Right now our research men are developing many new devices —some of them for the purpose of maintaining exact temperatures in mechanical, chemical or electronic processes—others for systems of thermostatic controls.

What we have done, what we have learned, may be of help in solving a problem of yours.

**Send for this *NEW BOOKLET***

It shows how H. & A. units can be engineered in nearly any size, shape and capacity. Write H. & A. Engineering Dept. 86 Leroy Ave., Buffalo 14, N. Y.



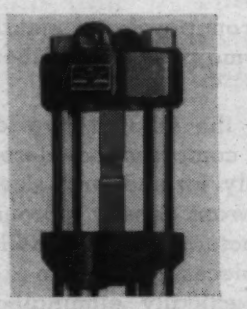

H & A
*Manufacturing Co. Inc.*
PLANTS IN BINGHAMTON AND BUFFALO, N. Y.

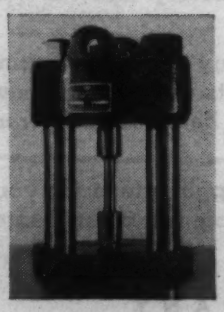
# NOW test weld specimens quickly and accurately!

## with the new AIRCO *Portable* TENSILE AND GUIDED BEND TESTING MACHINE

HERE'S the compact, portable, weld-testing machine you've been waiting for. It's sturdy and accurate, and provides a handy means of qualifying welding operators without the delay or inconvenience caused when tests must be made at distant laboratories.

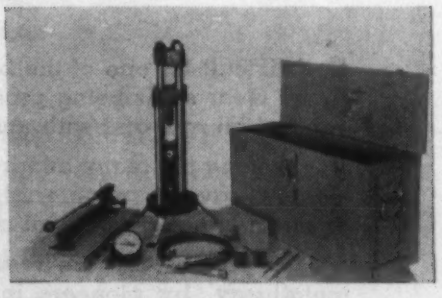
### IT MAKES ALL THREE TESTS:





1. Reduced section transverse tension tests (shown in top photo at right); 2. Guided bend tests (a complete 180° face or root bend), as shown in large photo above; 3. Longitudinal all-weld metal 0.505" tension tests (lower photo at right). *This is the only available portable testing machine that combines all three functions in one convenient, portable machine.*

This Airco machine operates on the principle of the hydraulic jack. Maximum direct load is 40,000 pounds, permitting tests on material of 150,000 psi. or higher tensile strength, by selecting the proper area for the test piece. A maximum hand mounted on the face of the gauge indicates the breaking load applied to the specimen.



Jaws for the transverse tension test, and plunger and die for the guided bend test are supplied with the machine. Jaws for the longitudinal all-weld metal tension test (0.505") coupon can be supplied on special order. All equipment is compactly installed in an oak cabinet which serves as a practical container for storage and shipment. The cabinet has handles at either end to facilitate carrying. For descriptive booklet giving complete data, mail the coupon below.

MAIL COUPON FOR BOOKLET

MA

Air Reduction Sales Co.
60 E. 42nd St.,
New York 17, N.Y.

Please send me by return mail free copy of your booklet ADI-889 describing the new Airco Tensile and Guided Bend Test machine.

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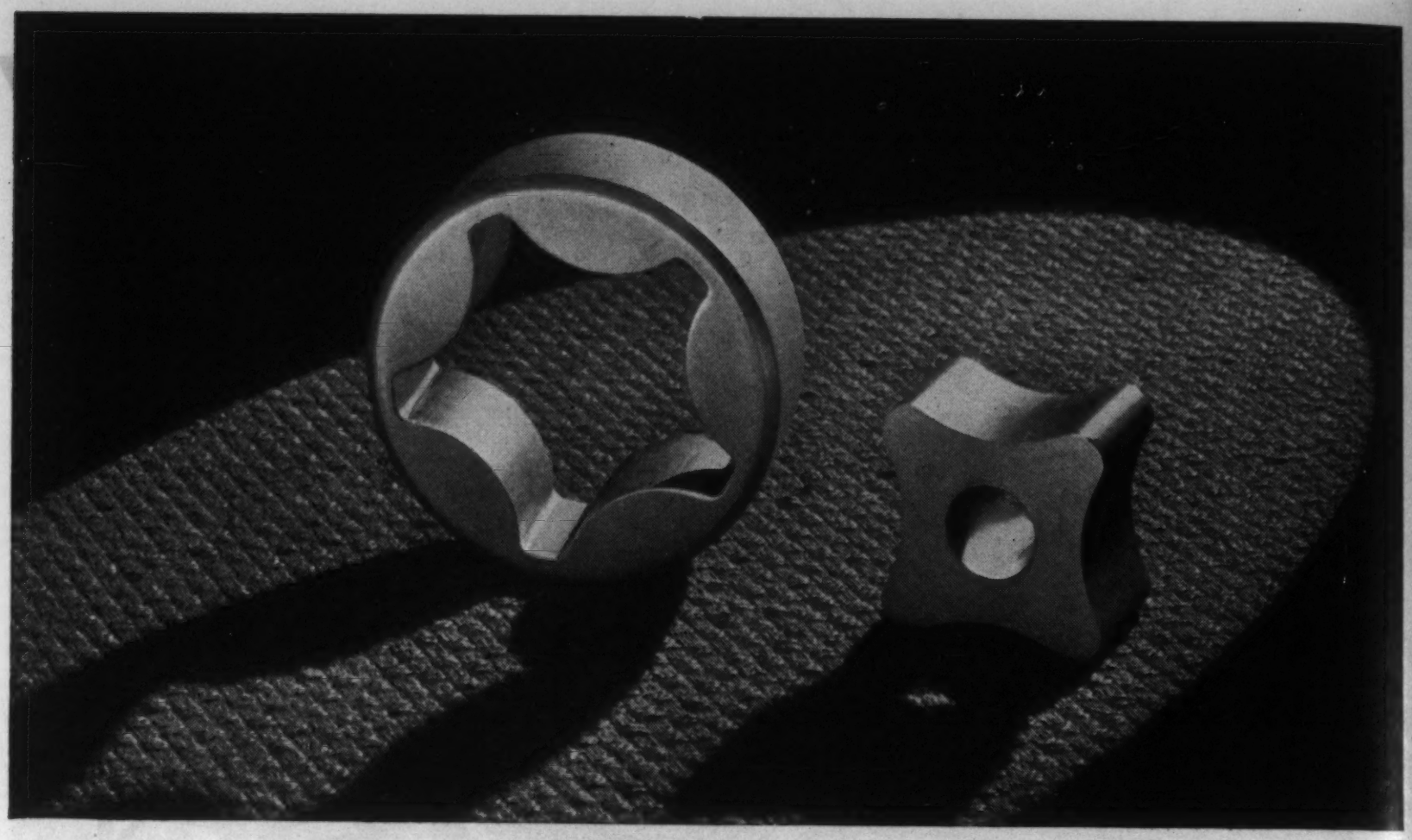


# *The Guts of a Pump in Two Strokes of a Press* . . . with precision that couldn't be matched at many times the cost

Too difficult for one of the best tool shops in this country to machine — this Oilite Pump Gear set is being produced from powdered metals, automatically, at a high production rate and with unskilled labor on Stokes Tabletting Machines.

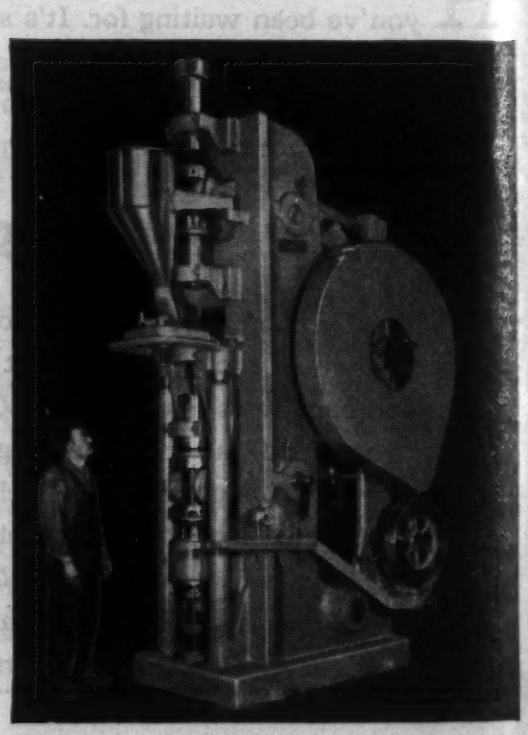
Yes, among the many hundreds of parts now being pressed from powdered metals — all at savings in material, time, labor and money — are some pieces that otherwise could not be made at all.

Stokes presses are the result of 25 years of experience in the field of powder metallurgy, by pioneers in this type of equipment. They compress powdered metals, under precisely controlled pressures, into accurately formed and sized metal parts ready for sintering. Such parts are dense, if you want density, porous, if you want porosity . . . for with Stokes presses these characteristics are readily controlled. Production rates are high . . . often hundreds of pieces per minute . . . depending on size, intricacy, materials, etc. Waste is practically eliminated. Skilled operating labor is unnecessary. Parts produced are closely uniform both in dimensions and physical characteristics.

Stokes Machines are rugged, heavy duty presses . . . in many cases, operating continuously at more than 70% overload, making accurate parts without excessive deflection of the press. They stand up in this difficult service because they were designed for it.

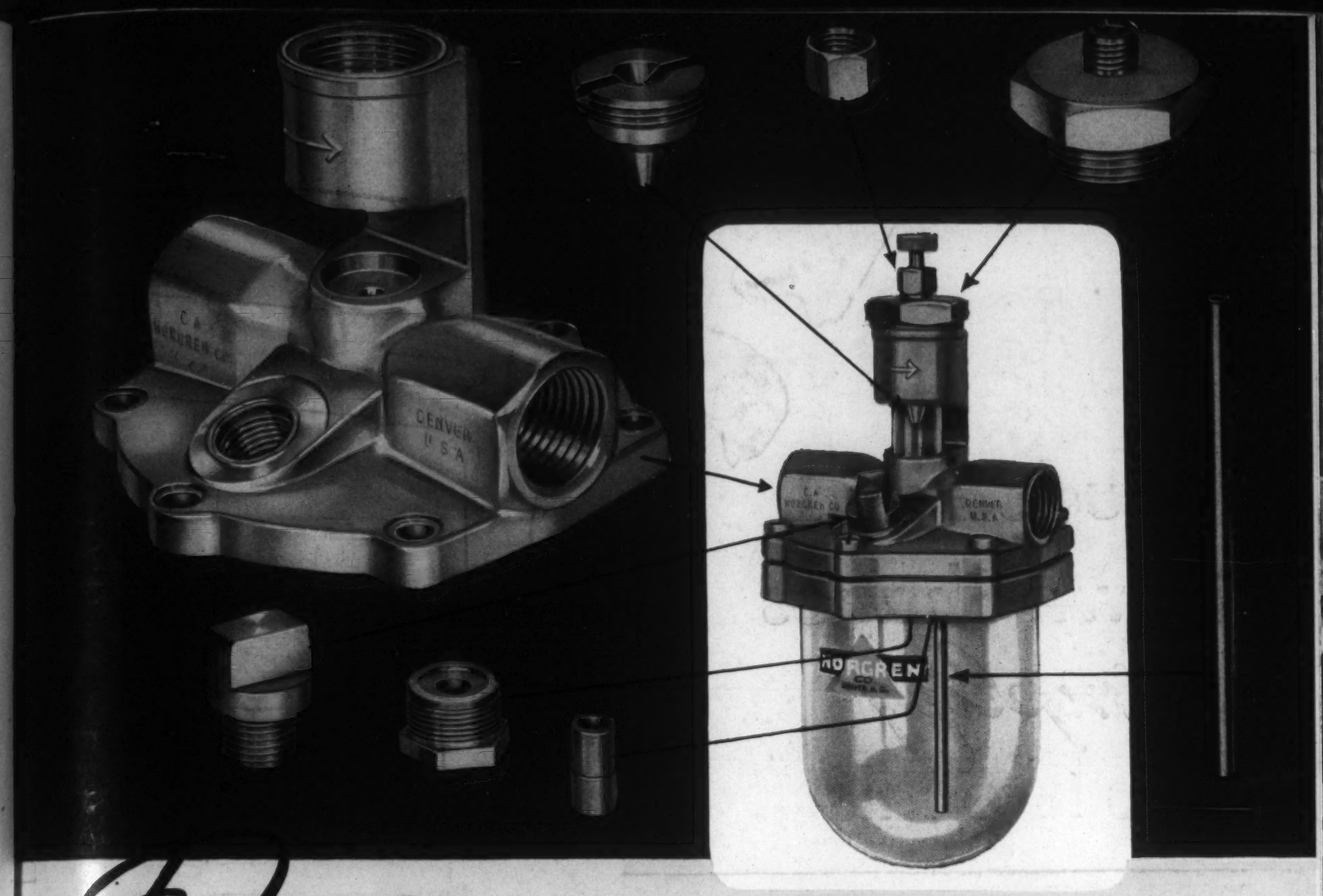
Let us make recommendations on methods, equipment, and applications for your specific pressing problems. Our laboratory facilities are available for experimental work. Write for complete 48-page illustrated catalog.

F. J. STOKES MACHINE COMPANY
5972 Tabor Road Philadelphia 20, Pa.



*Model "P-2" Powdered Metals Compressing Machine. Pressure applied from both above and below for uniform density. Maximum tablet size, 4" dia. Maximum die fill, 8". Pressure, 60 tons.*

F.J.Stokes AUTOMATIC TABLETTING EQUIPMENT FJS Est. 1895




# *Doubling* IN BRASS

THE BANDMASTER who boasts of musicians that "double in brass" knows he has an added value —something extra to give his audience. Many manufacturers feel the same way about the use of Anaconda Hot Pressed Parts in their products.

Let's take, for example, the C. A. Norgren Co. of Denver, Colorado, manufacturers of the Norgren Air Line Lubricator illustrated above. This pneumatic tool lubricator is placed in the air line and is automatic in operation—"it starts when the tool starts—stops when the air flow stops."

An Anaconda Hot Pressed Part was selected for the brass body for two reasons: First, this method of manufacture is ideally adaptable to its unusual design. Parts are uniform, more alike than peas in a pod. Clean, smooth surfaces, free of foundry sand, scale and dross, enhance its appearance, help to make machining easy, reduce scrap, increase tool life.

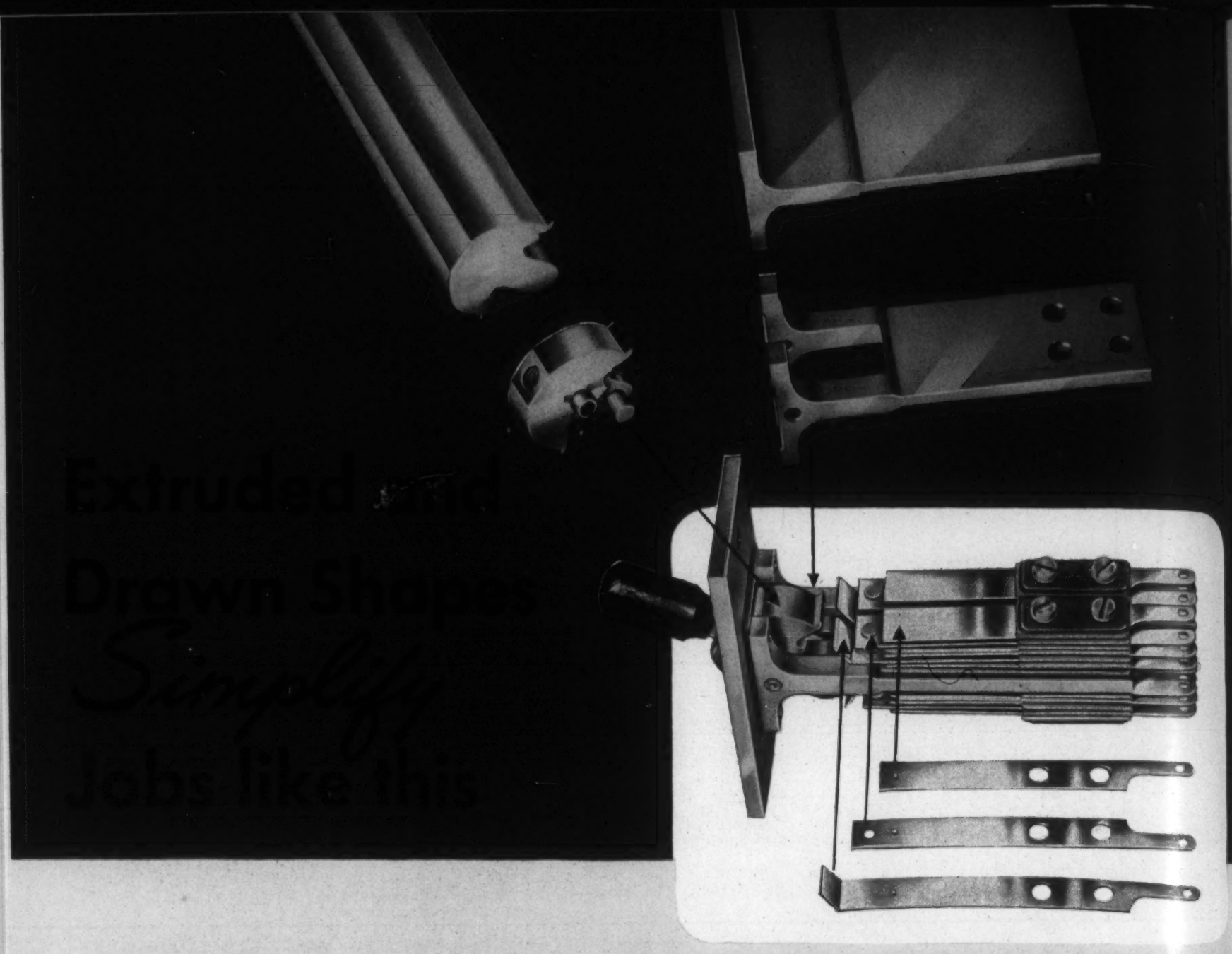
The second reason is even more important: These hot pressed parts have double the strength of ordinary sand castings, yet the total cost—per machined and tested piece—is little, if any, more. Being made of *wrought* metal, they are free from internal defects, are gas, air, oil and watertight . . . assurance of dependable, on-the-job performance.

The screw machine parts also illustrated above have a story of their own, as told by Mr. C. A. Norgren, General Manager:

> "For many years we have used The American Brass Company's free cutting brass rod and tubing. Those were trouble-free years as far as our screw machine operations were concerned. Then came the war with the material controls with which all of us are now familiar. We did what everyone else would have done under the circumstances—shopped the market from Boston to San Francisco. Instead of one source of supply, we found we were purchasing 'free cutting brass' from as many as eighteen different sources.
>
> "Many trade names were lost in the shuffle and, much to our surprise, we found that all brass rod was not *good* brass rod. We found it necessary to give unusual consideration to screw machine jobs where formerly trouble-free operation was the rule. We looked forward with pleasure to the time when The American Brass Company could again fill all our orders without restrictions and we could rely on our vast records of tooling, speeds and feeds which have proved so economical in our screw machine operations."

ANACONDA

*Anaconda Copper & Copper Alloys*


Extruded
Drawn
Shapes
Jobs like this

SIMPLIFICATION IS AN ECONOMIC NECESSITY on an assembly such as this multi-pole, double-throw key switch made by the Kellogg Switchboard & Supply Company of Chicago. Used throughout the telephone industry and by manufacturers of radio, electronic and control equipment, this key, illustrated above in actual size, is made up of more than a hundred component parts—67 of them metal, and most of them copper alloys—from the brass escutcheon to the nickel silver springs.

Simplicity, accuracy and economy go hand in hand in the production of the two most complicated parts of this key—the cam and the frame. These two intricately formed pieces are literally "sliced" off long mill lengths of Anaconda Extruded-and-Drawn Shapes.

The slot milled, ten holes drilled and four tapped, the frame is ready for assembly—providing adequate strength and rigidity, and accuracy of contour and dimensions. The cams are milled to close tolerances, drilled and tapped. Integral pins for the rollers are shell milled—cam action is always smooth, no parts can work loose. Little wonder that similar Kellogg Keys, made of materials supplied by The American Brass Company, are still in service after twenty-five years of "24 hours a day, seven days a week" service on switchboards of some of the busiest exchanges.

Compare this method of producing complicated parts from readily machinable Anaconda Shapes with the costly processes involved by any other method—machining from bar stock or sand castings, stamped parts or built-up assemblies.

The American Brass Company produces copper, brass, bronze, nickel silver and special copper alloys in practically all commercial forms—sheets, strips, plates, wire, rod, tubes, special extruded, rolled and drawn shapes, hot pressed parts and pressure die castings. The manufacture of such a wide range of copper alloy products places us in a position to suggest "the one best metal to do the best possible job for a specific application." Our Technical Department will be glad to work with you.

44116

**THE AMERICAN BRASS COMPANY**

*General Offices:* Waterbury 88, Connecticut • Subsidiary of Anaconda Copper Mining Company

*In Canada:* ANACONDA AMERICAN BRASS LTD., *New Toronto, Ontario*

ANACONDA
from mine to consumer

*Anaconda Extruded & Drawn Shapes*

# Stainless and Carbon Steel Castings to Micrometer Tolerances

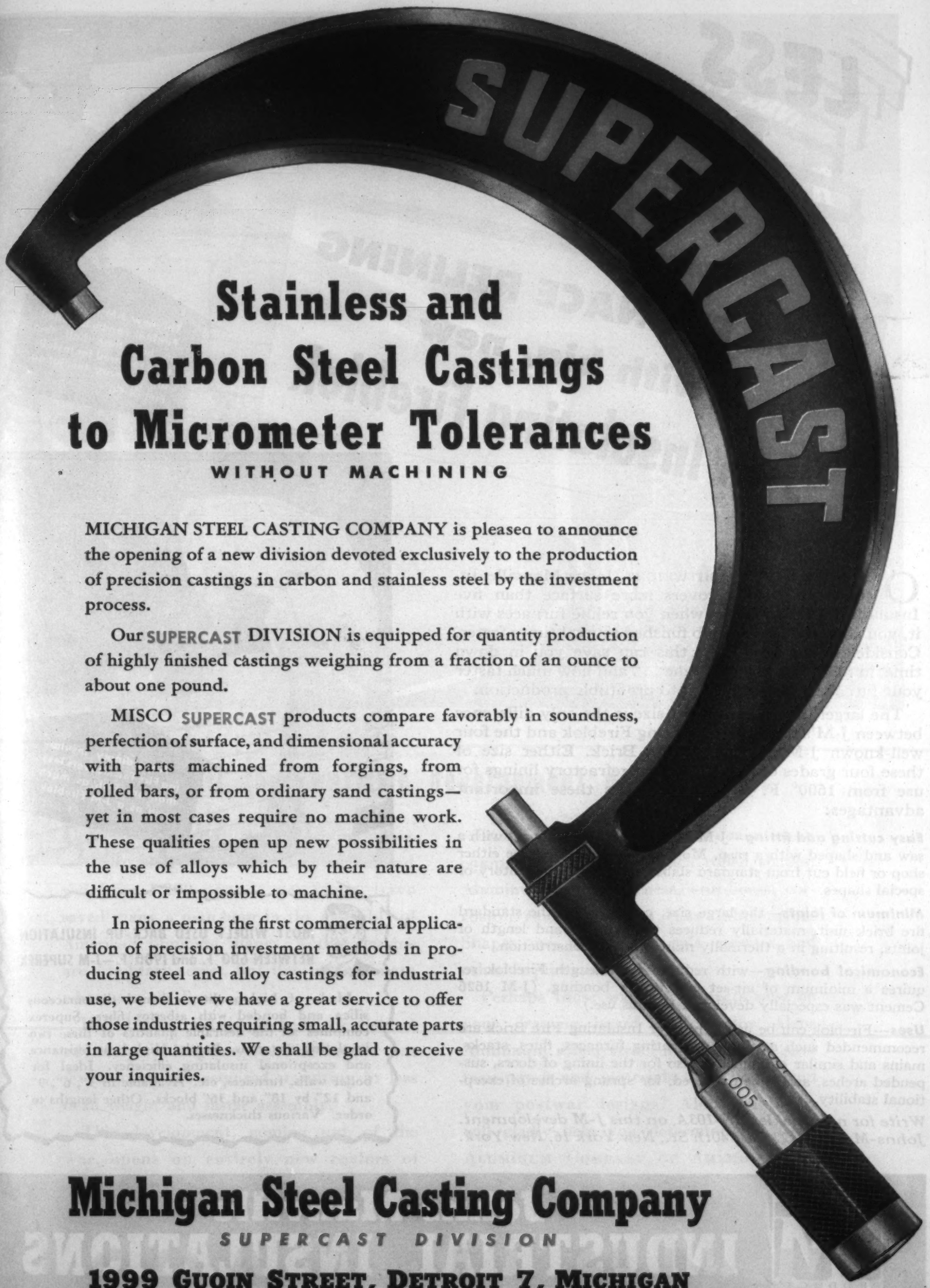
WITHOUT MACHINING

MICHIGAN STEEL CASTING COMPANY is pleased to announce the opening of a new division devoted exclusively to the production of precision castings in carbon and stainless steel by the investment process.

Our SUPERCAST DIVISION is equipped for quantity production of highly finished castings weighing from a fraction of an ounce to about one pound.

MISCO SUPERCAST products compare favorably in soundness, perfection of surface, and dimensional accuracy with parts machined from forgings, from rolled bars, or from ordinary sand castings—yet in most cases require no machine work. These qualities open up new possibilities in the use of alloys which by their nature are difficult or impossible to machine.

In pioneering the first commercial application of precision investment methods in producing steel and alloy castings for industrial use, we believe we have a great service to offer those industries requiring small, accurate parts in large quantities. We shall be glad to receive your inquiries.



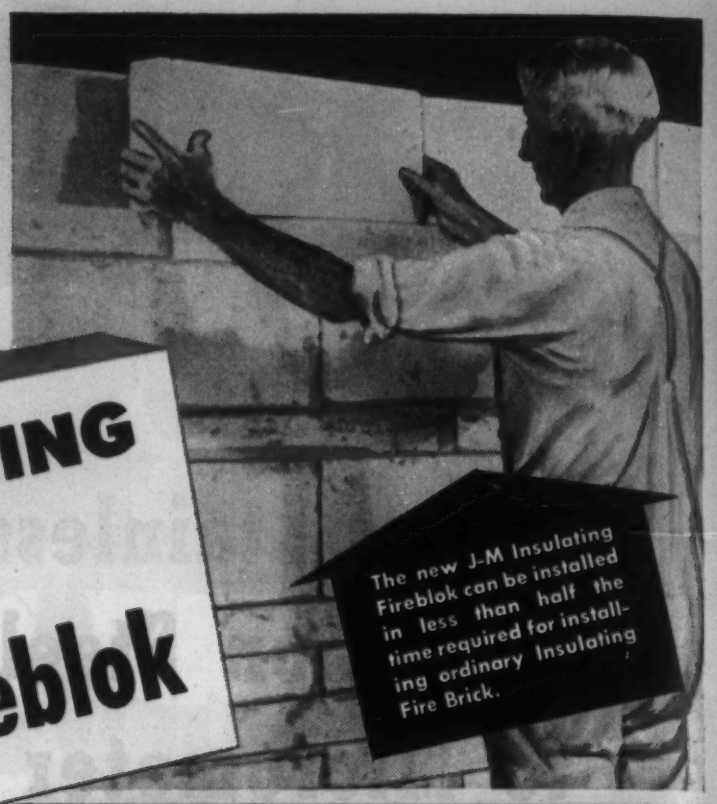

## Michigan Steel Casting Company

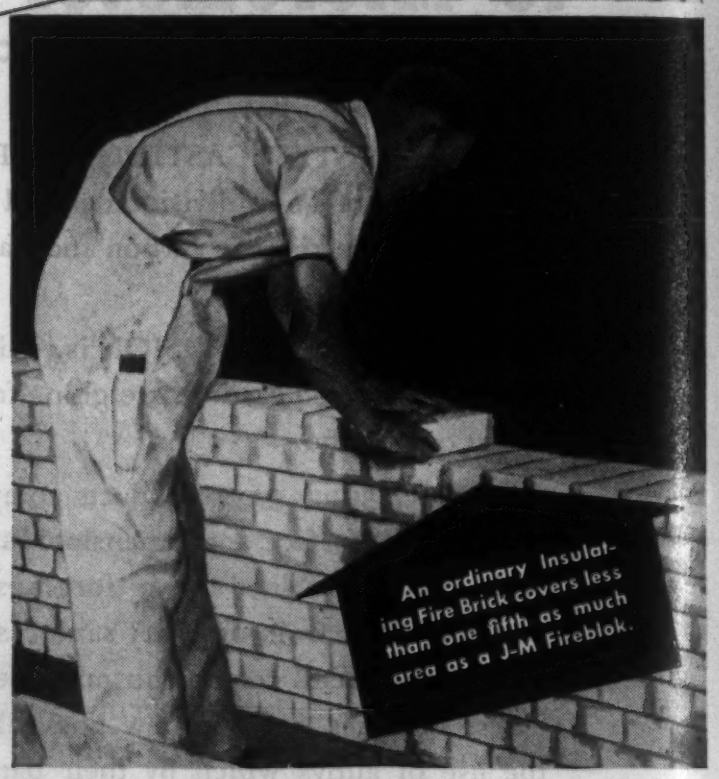
SUPERCAST DIVISION

1999 GUOIN STREET, DETROIT 7, MICHIGAN

# LESS DOWN TIME

## FOR FURNACE RELINING with big, new J-M Insulating Fireblok




ONE OF THE NEW LIGHTWEIGHT Johns-Manville Insulating Fireblok covers more surface than five Insulating Fire Brick. So, when you reline furnaces with it, you can often get the job finished several times faster. Consider how many hours this can save you in down time, in maintenance crew time . . . and how much faster your furnaces can get back into profitable production.

The larger, more convenient size is the only difference between J-M's four new Insulating Fireblok and the four well-known J-M Insulating Fire Brick. Either size of these four grades of highly efficient refractory linings for use from 1600° F. to 2600° F., has these important advantages:

***Easy cutting and fitting***—J-M Fireblok can be easily cut with a saw and shaped with a rasp. Most special shapes can be either shop or field cut from standard slabs, reducing the inventory of special shapes.

***Minimum of joints***—the large size, compared to the standard fire brick unit, materially reduces the number and length of joints, resulting in a thermally more efficient construction.

***Economical bonding***—with reduced joint length Fireblok requires a minimum of air-set cement for bonding. (J-M 1626 Cement was especially developed for this use.)

***Uses***—Fireblok can be used wherever Insulating Fire Brick are recommended such as for heat-treating furnaces, flues, stacks, mains and similar equipment. Also for the lining of doors, suspended arches, and, when tapered, for sprung arches of exceptional stability.

*Write for new booklet, IN-103A, on this J-M development. Johns-Manville, 22 East 40th St., New York 16, New York.*

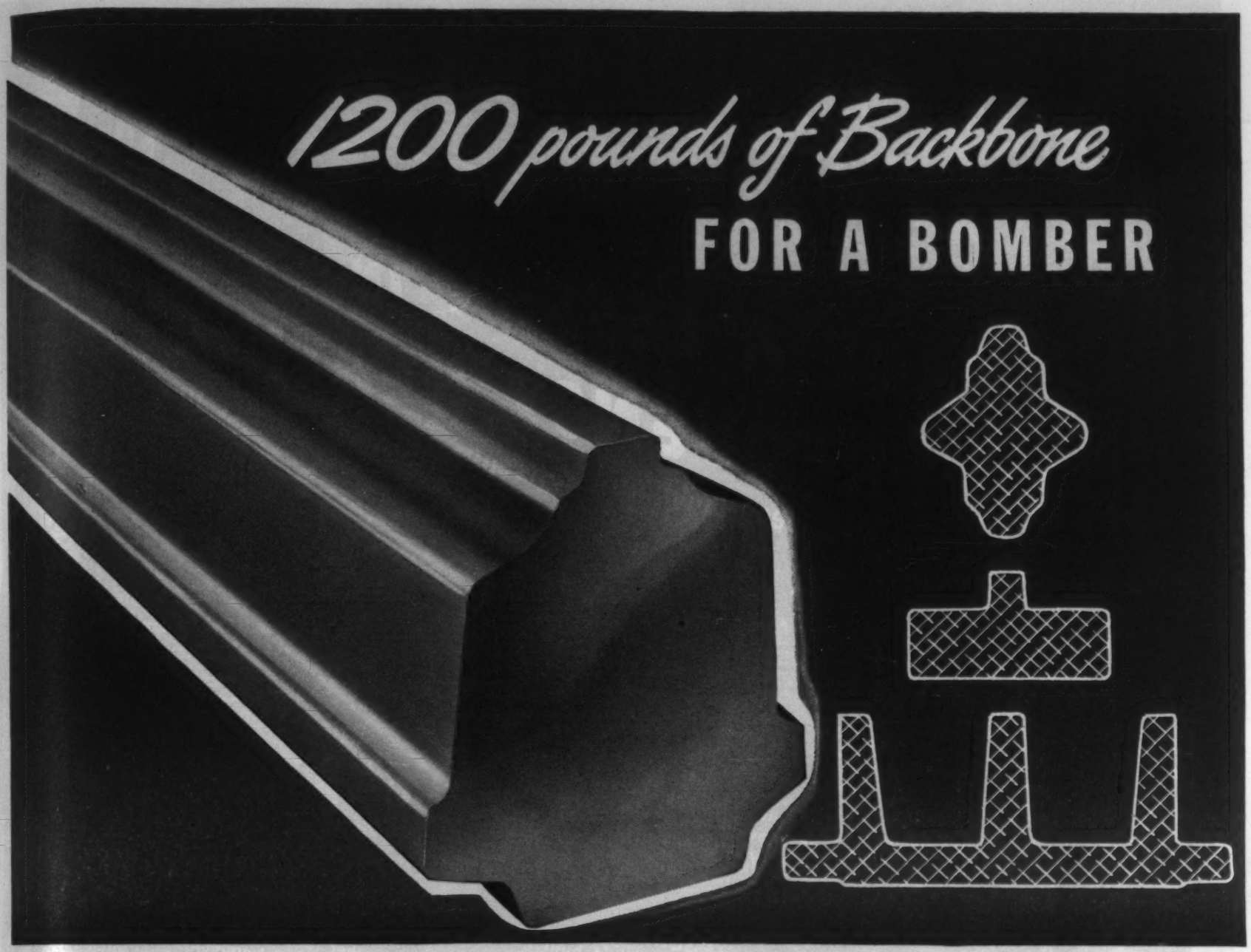
**MOST WIDELY USED BACK-UP INSULATION BETWEEN 600°F. and 1900°F.—J-M SUPEREX**

Made of high-quality, calcined diatomaceous silica and bonded with asbestos fiber, Superex combines all the desirable qualities of these two insulating materials. Result: High heat resistance and exceptional insulating efficiency. Ideal for boiler walls, furnaces, etc. Available in 3", 6", 9" and 12" by 18" and 36" blocks. Other lengths to order. Various thicknesses.

JOHNS-MANVILLE JM PRODUCTS

**Johns-Manville INDUSTRIAL INSULATIONS**

*FOR EVERY TEMPERATURE...FOR EVERY SERVICE*




## What will this wartime development do for you?

Alcoa special rolled shapes having cross sections as large as thirty square inches, and weighing 1,200 pounds per piece, have saved many a man-hour in the assembly of America's bombing planes. Actual designs are a military secret, but they approximate what you see here.

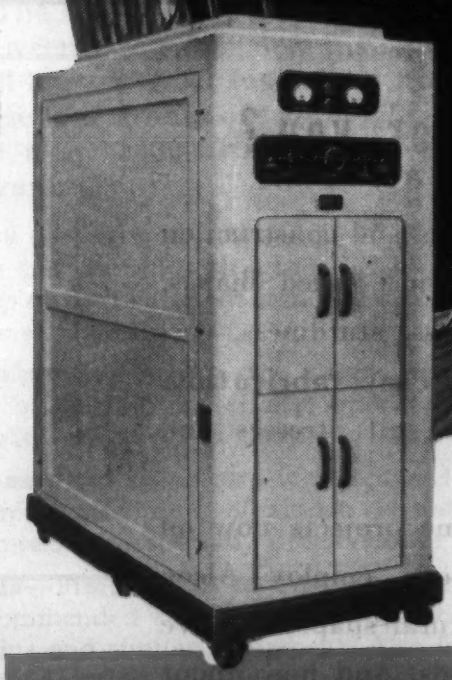
Rolled structural shapes have the distinct advantage of long lengths. This means that fewer joints are required, resulting in less dead weight and faster assembly.

This development, coming out of the war, opens up entirely new realms of design. As in our airplanes, builders of railroad cars, buses, boats and construction equipment can employ such rolled shapes. Aluminum gives lightness, sturdiness, corrosion resistance and easy fabrication. Shapes are tailored to suit stresses and other requirements.

Perhaps those wartime projects now on your drawing board can employ Alcoa Aluminum rolled structural shapes to save man power and materials. And how about your postwar designs? Alcoa engineers will gladly help you determine the facts. ALUMINUM COMPANY OF AMERICA, 2107 Gulf Building, Pittsburgh 19, Pennsylvania.

**ALCOA ALUMINUM**

REG. T. M.



Our equipment offers you a selection of frequencies up to 300 megacycles — and the following power range, with stepless control from zero to full load:

- 5 Kw
- 7½ Kw
- 10 Kw
- 12½ Kw
- 15 Kw
- 18 Kw
- 25 Kw
- 40 Kw
- 100 Kw

**We're *pioneers* in high frequency heating with 23 years of valuable knowledge and experience—at your service. What we have learned about heater unit circuits can prevent you from making costly errors in equipment selection and application.**

**Our extensive line of equipment offers you the widest range of power and frequency combinations. Choice is not limited to "standard" units. Let a pioneering *specialist* solve your heating problems by giving you exactly the right installation for *your* applications. It will pay you to get in touch with us before you choose ANY high frequency heating unit. Write us today.**

# Scientific Electric

DIVISION OF "S" CORRUGATED QUENCHED GAP COMPANY

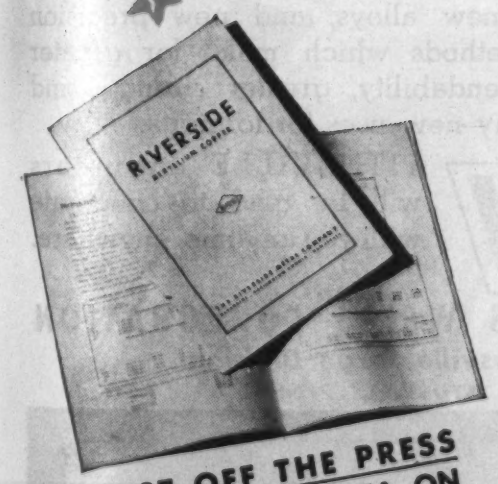
**119 Monroe Street** **Garfield, New Jersey**

**Designers and Builders of High Frequency Converters Since 1921**

# Improved Products with RIVERSIDE BERYLLIUM COPPER

Wrought Beryllium Copper has an unusual combination of properties. Springs made from this Riverside alloy are used for a great many applications in the precision equipment of our armed forces. When properly heat treated, it is the strongest copper base alloy. Design engineers utilize its high strength and precipitation hardening qualities in the manufacture of aircraft instrument springs where space and light weight are of vital importance. A great advantage to fabricators is that springs may be formed from rolled sheet or drawn wire of moderate temper and then heat treated to develop the alloy's extraordinary high strength and spring properties. Beryllium Copper is much stronger and stiffer than other copper alloys, yet it offers equally good corrosion and wear resistance. It has greater resistance to fatigue and higher electrical conductivity. Correctly heat treated Beryllium Copper springs are more stable and resistant to drift than any other spring material; hence the wide use of this alloy for instrument and other calibrated springs in vital applications. The advantages of Beryllium Copper springs have been definitely proved both for war and peace time applications.

The Riverside Metal Company specializes in the production of wrought Beryllium Copper alloy, and a great variety of Phosphor Bronze and Nickel Silver alloys to standard or consumers' individual specifications in sheet, strip, wire and rod. The cooperation of our technical staff on any problem involving the application of these vital alloys is yours for the asking.




**JUST OFF THE PRESS**
**NEW REVISED DATA ON RIVERSIDE BERYLLIUM COPPER**
**Send for this booklet today!**

## THE RIVERSIDE METAL COMPANY

*Producers of these Vital Alloys:*

PHOSPHOR BRONZE • NICKEL SILVER • BERYLLIUM COPPER
Sheet Strip Wire Rod

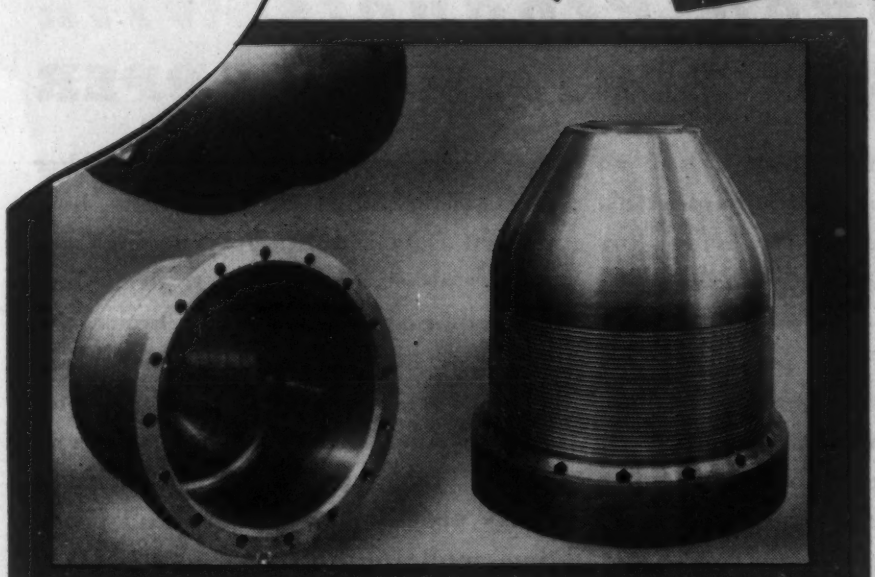
RIVERSIDE . . . Burlington County . . . NEW JERSEY
NEW YORK HARTFORD CLEVELAND CHICAGO

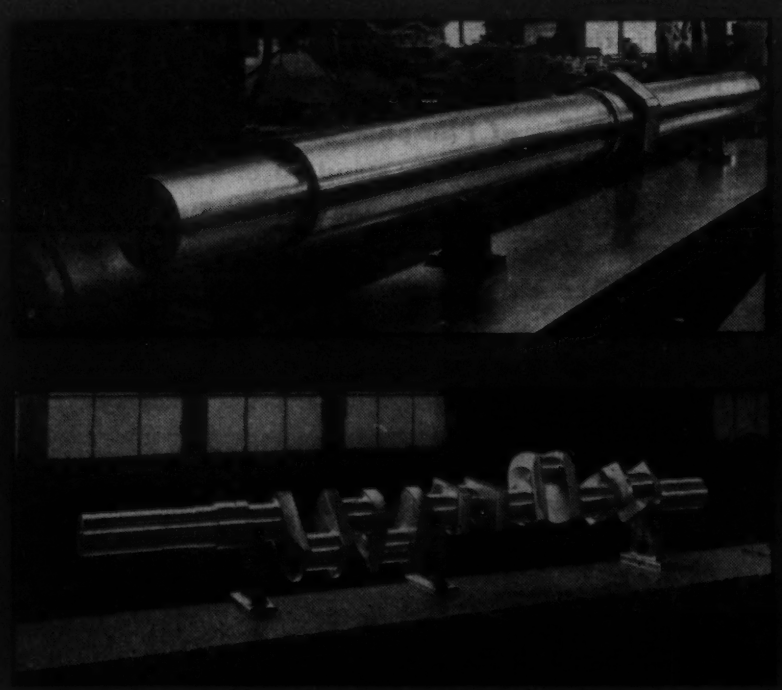
# TITUSVILLE

*A good name to Remember when you need*

## HEAVY STEEL OR ALLOY

*Forgings*





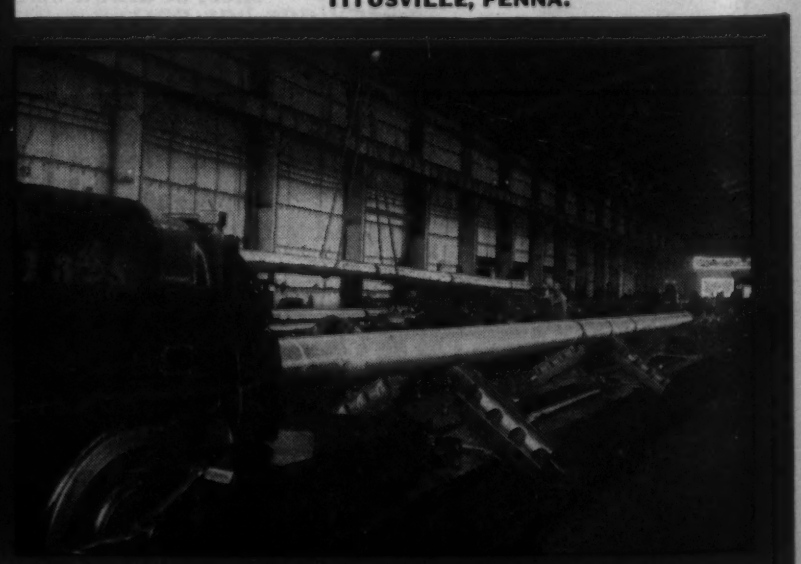
TITUSVILLE has always been a dependable source for quality Forgings. Now, with unexcelled manufacturing facilities, and over fifty years experience in making difficult forgings, TITUSVILLE is,—more than ever before,—your logical headquarters for dependable heavy steel or alloy forgings, always. Our engineering and production skill has been greatly enhanced by wartime "know-how"—in utilizing to best advantage the new alloys, and new precision production methods which make for greater dependability, greater strength and many new uses for forgings.

TITUSVILLE engineers will be glad to cooperate with you anytime, anywhere.

**STRUTHERS WELLS CORPORATION**

***Titusville Forge Division***

**TITUSVILLE, PENNA.**



# "SHIPYARD SPEED"

## ON ALL METAL FORMING JOBS

This W-S self-contained hydraulic press is doing an efficient metal forming job in a Navy shipyard where fast production of parts and shapes is vital. In the same way that this press is helping to speed shipbuilding and repair, all W-S metal forming presses will produce fast-forming operations in many metal working plants.

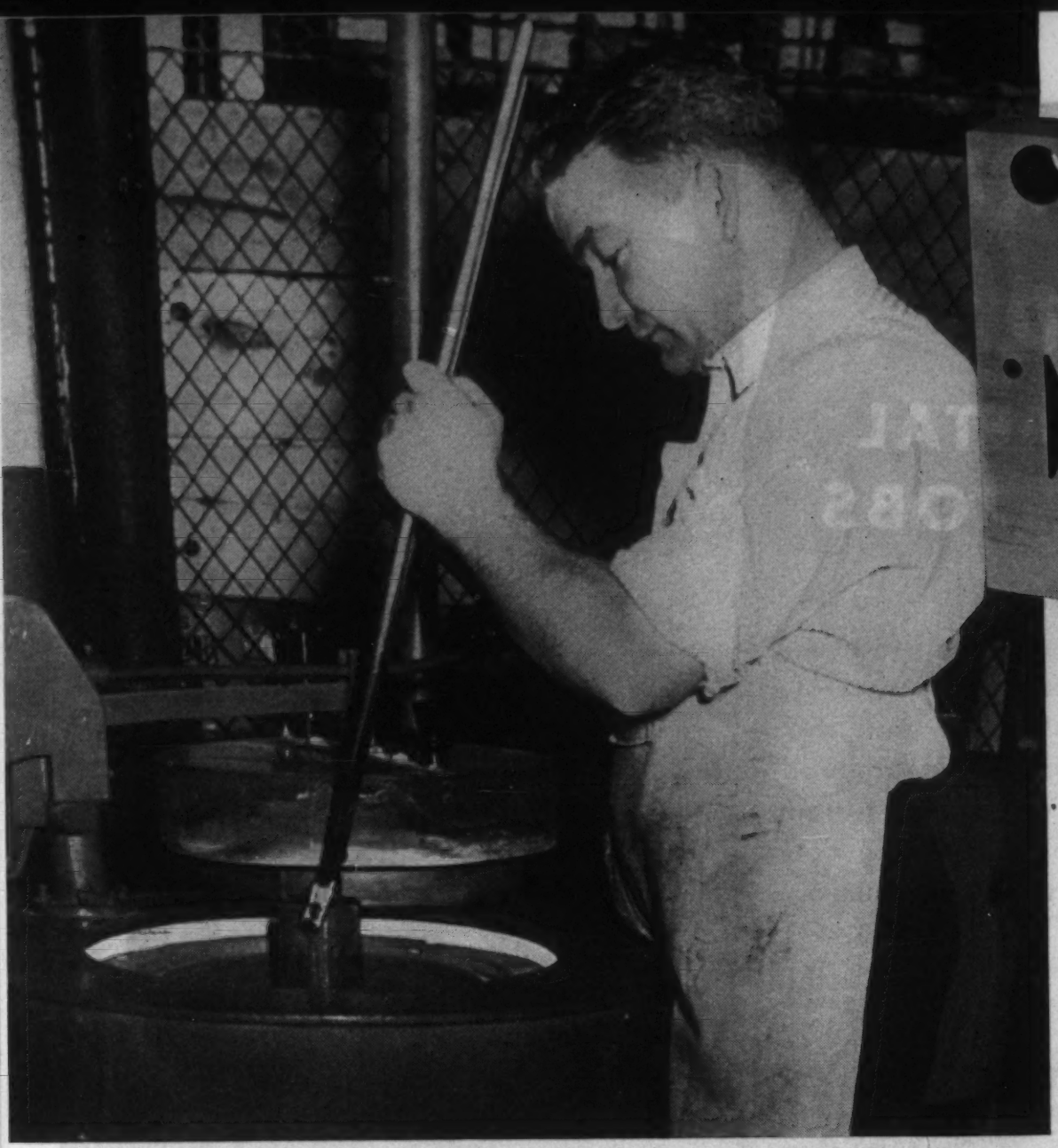
*Standing 12 ft. high on floor space of approximately 7 ft. by 5½ ft., this 200-ton single action forming press has a pressing speed of 78 in. per min. with traverse speed of 700 in. per min. Bolster area is 48" x 36"; slide stroke 20"; shut height 16". Driven by 50 h.p. motor.*

Watson-Stillman Metal Forming Presses are made in single and double action types, with and without cushion cylinders. Where cushion cylinders are used they are arranged so that they can provide only a cushion and also obtain separate action if required.

Automatic, electrical single-cycle control equipment, with gauges, auxiliary valve, etc. are panel mounted. Write for complete specifications and details. The Watson-Stillman Co., Roselle, New Jersey.

# WATSON-STILLMAN

**DESIGNERS AND MANUFACTURERS OF HYDRAULIC EQUIPMENT, VALVES, FORGED STEEL FITTINGS**



*Heat-treater placing an embossing die in an Vapocarb-Hump Hardening Furnace*

# MUST TOOLS PRODUCE MORE?

## Vapocarb-Hump Hardening Helps in 3 Ways

During this year's Battle of Production, hundreds of metal-working plants are finding that the Vapocarb-Hump Method of Hardening helps to bring about big increases in the life of punches, dies, hobs and other war-production tools.

If you have a war-goods tooling problem, we'll gladly arrange for you to talk to people in some of these plants. They'll tell you of three ways in which tool life is prolonged: (1) By lessening or ending warp. (2) By better depth of hardness. (3) By ending all surface blemishes.

But, because all three seldom are found in one tool, we're showing here an example of each. You'll understand why these cases must be taken from pre-war production!

### Warp Defeated In Perforation Die

A Maryland company used to make 2 or 3 big diamond-pattern perforating dies at a time, because heat-treating warp twisted them "like pretzels," and grinding them straight weakened them and shortened their lives. Vapocarb-Hump hardening, by its uniform heating, ended warp and doubled the lives of these tools.

### One Die Does Work of 30

Belt buckle dies were producing an average of 1200 pieces, because the heat-treater could only guess when to quench them, in hardening, and their structure was accordingly weak. Vapocarb-Hump Hardening, by locating *and recording* the critical point, helped increase the production, successively, to 2300 pieces, then 8500, then 18,000 and finally 38,000—an average of 30 times the pre-Vapocarb figure.

### Perfect Surface For Stamping Die

Life of engraved dies, like the one shown, was often shortened because the method of hardening which was employed permitted surface pits or scale to form. These had to be "polished" out, thus weakening the hardened skin. Vapocarb-Hump hardening eliminated this because its protective atmosphere ends all scaling and pitting in furnace; average life of dies has been sharply increased.

Further particulars of Vapocarb-Hump Hardening are given in Catalog T-621, or an engineer will call on request to discuss a specific problem.

*Warp Ended Means No Grinding*

*Correct Structure Increases Production*

*Perfect Surface Saves Hours of Polishing*

**A Slogan For Every American**

LEEDS & NORTHRUP COMPANY, 4925 STENTON AVE., PHILA.

LEEDS & NORTHRUP

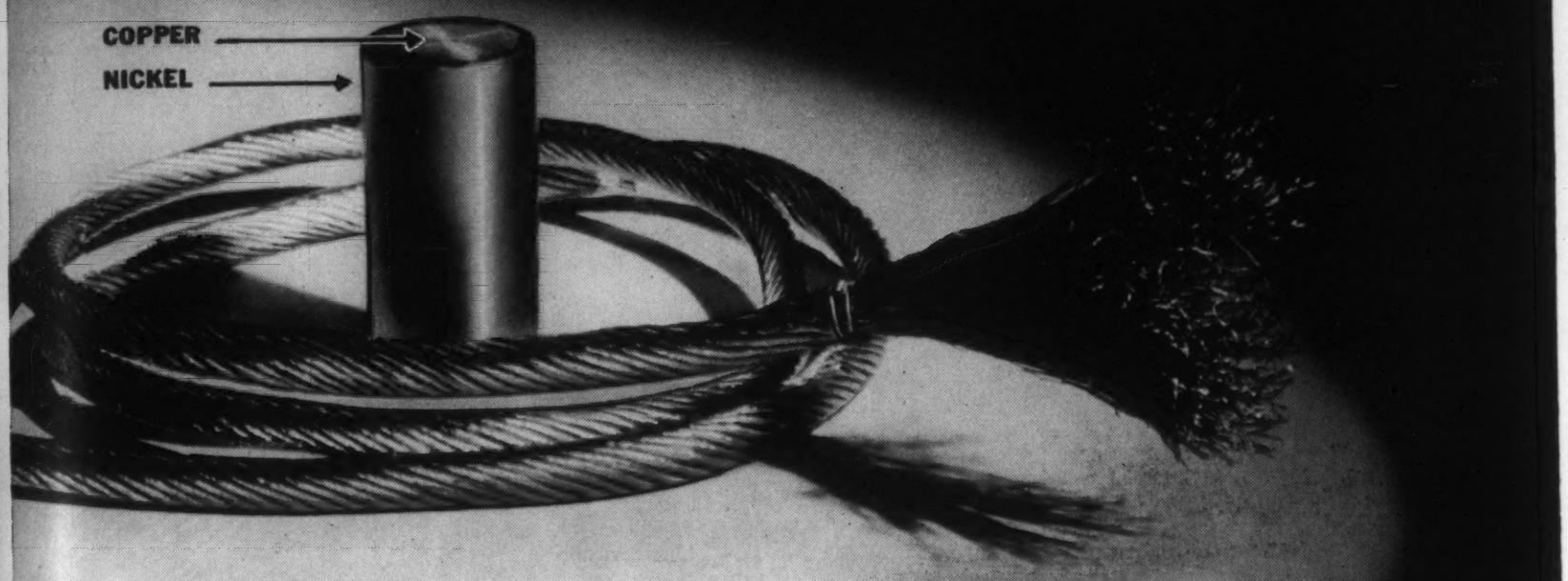
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FU

Jrl. Ad T-621(27)

*They wanted*

# A METAL THAT DIDN'T EXIST

## *...but an ingenious combination met all requirements*




A new metal was needed for wire . . . with a combination of properties not found in nature.

It had to have high heat and electric conductivity *plus* strength and resistance to oxidation at high temperatures.

Copper had the required conductivity but it couldn't stand the heat.

Nickel had the high-temperature strength and corrosion resistance but its conductivity was too low.

The answer was an ingenious combination, "Kulgrid", devised by Callite Tungsten Corp., Union City, N. J. It consists of a copper core, over which is firmly bonded a sleeve of strong, corrosion-resistant Nickel.

The result is a conductor with 70% of copper's conductivity . . . 100% of Nickel's resistance to oxidation and corrosion. It can stand up under high temperatures, fatigue, embrittling conditions, and stresses four times greater than copper without breaking.

One of the INCO Nickel Alloys may be the answer to *your* metal problem. Tough, strong and corrosion-resistant as a family . . . and with individual *specialized* properties . . . they are available in practically any shapes and sizes that may be wanted down to

***wire,*** ⅓ the thickness of human hair
***tubing,*** finer than a mosquito's stinger
***strip,*** ⅓ the thickness of this paper

"Tremendous Trifles," a booklet which discusses the INCO Nickel Alloys in detail will be sent to you on request.

**THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK 5, N. Y.**

**THE CYLINDER** *is a section of bi-metal rod . . . copper core and nickel jacket. It is cold-drawn by Callite Tungsten Corp., to the .006" fineness of the flexible stranded wire illustrated.*

**FIRST STEP IN MAKING "KULGRID"** *bi-metal wire is insertion of copper rod into Pure Nickel tube. The two-in-one wire has 70% of the conductivity of copper . . . is strong and corrosion-resistant, even at high temperatures.*

**INCO NICKEL ALLOYS**

**MONEL • "K" MONEL • "S" MONEL • "R" MONEL**
**"KR" MONEL • INCONEL • NICKEL • "Z" NICKEL**

***Sheet...Strip...Rod...Tubing...Wire...Castings***

## COMPOSITION AND CHARACTERISTICS

| ALLOY | Nominal Compositions—per cent | | | | CHARACTERISTICS |
|---|---|---|---|---|---|
| | Aluminum | Manganese | Zinc | Magnesium | |
| Dowmetal J-1 | 6.5 | 0.2 | 1.0 | Remainder | For press forgings of good strength and resistance to s water. |
| Dowmetal M | .. | 1.5 | .. | Remainder | Moderate strength alloy. Can be used for both press a hammer forgings. |
| Dowmetal O-1 | 8.5 | 0.2 | 0.5 | Remainder | Highest strength press forgings of simple design. Avc able in forged, aged, or heat treated and aged con tions depending upon strength requirements. |

# DOWMETAL *magnesium products*

THE METAL OF MOTION

*vailable—to everyone interested:*

Dow and Magnesium"—a booklet cov-ring the statement filed by The Dow hemical Company with the Special Com-ittee of the U. S. Senate investigating e National Defense Program (The Tru-an Committee) on March 6, 1944, to-ether with extracts covering the cross-xamination and the report of the ommittee. This book is of extreme interest nd importance to American Industry. A opy will be sent on request.

## MECHANICAL PROPERTIES OF FORGINGS[1]

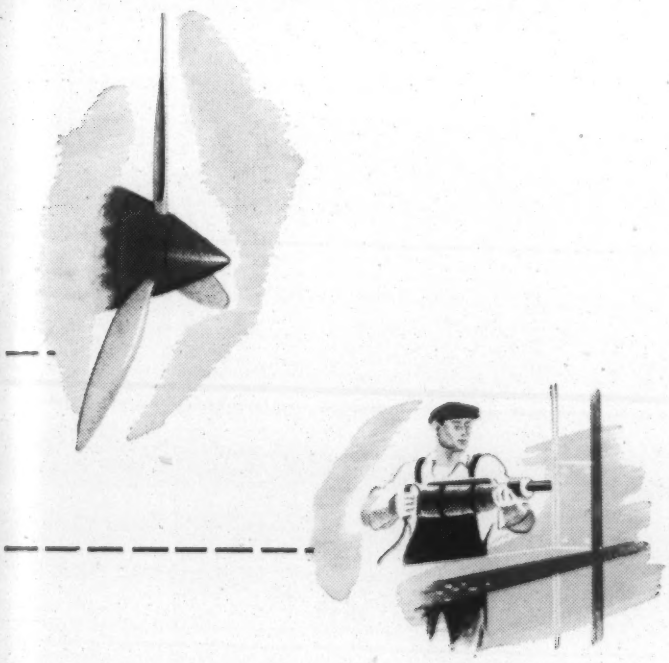
| ALLOY | CONDITION | TENSION | | | | | | COMPRESSION | HARDNESS | | FATIG |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Tensile Strength lb. per sq. in. | | Yield Strength[2] lb. per sq. in. | | Elongation % in 2 in. | | Yield Strength lb. per sq. in. | Brinell 500 Kg. load 10 mm. Ball | Rockwell E | Endura limit 500,000 cycle lb. pe sq. in |
| | | Typical | Specified Minimum | Typical | Specified Minimum | Typical | Specified Minimum | | | | |
| Dowmetal J-1 | As forged | 42,000 | 38,000 | 27,000 | 22,000 | 12 | 6 | 18,000 | 57 | 68 | 16,00 |
| Dowmetal M | As forged | 36,000 | 29,000 | 26,000 | 12,000 | 7 | 2 | ..... | 47 | 54 | ..... |
| Dowmetal O-1 | As forged | 46,000 | 42,000 | 32,000 | 24,000 | 10 | 5 | 22,000 | 65 | 76 | 18,00 |
| Dowmetal O-1A | Aged | 48,000 | 42,000 | 34,000 | 28,000 | 6 | 2 | 26,000 | 72 | 82 | 16,00 |
| Dowmetal O-1HTA | Heat Treated and Aged | 50,000 | ..... | 34,000 | ..... | 6 | .. | 24,000 | 72 | 82 | 16,00 |

[1]Press forgings. [2]Determined by 0.2% offset method.

# THE USE OF FORGINGS

***Number 3 in a Series***

# DATA FOR PRODUCT DESIGNERS



Magnesium forgings possess a desirable combination of strength, light weight, and pressure tightness. Forgings usually are made with press forging equipment. Hammer forgings can be used for applications where maximum strength is not required. Dies designed for use with other metals ordinarily can be used for magnesium alloys, since draft and shrinkage variations will be slight. Extruded rather than cast material is recommended for forging stock, because it allows a wider forging temperature and a greater speed of forging.

SHAPES AND SIZES AVAILABLE: Magnesium press forgings are available in the same variety of shapes and sizes in which other metals are normally produced. Dies can be adapted, in most cases, to available equipment at small expense.

If you wish to take advantage of the weight saving offered by this lightest structural metal, you are invited to consult Dow. Technical data covering all aspects of the fabrication and utilization of magnesium, drawn from 25 years of experience, is available. Dow also maintains an extensive metallurgical and engineering service which is at the disposal of all who are working in the fields of transportation, portable tools, mechanical equipment and wherever else the reduction of weight is essential.

## *Write for the New Booklet*

**"DOWMETAL MAGNESIUM ALLOYS"**

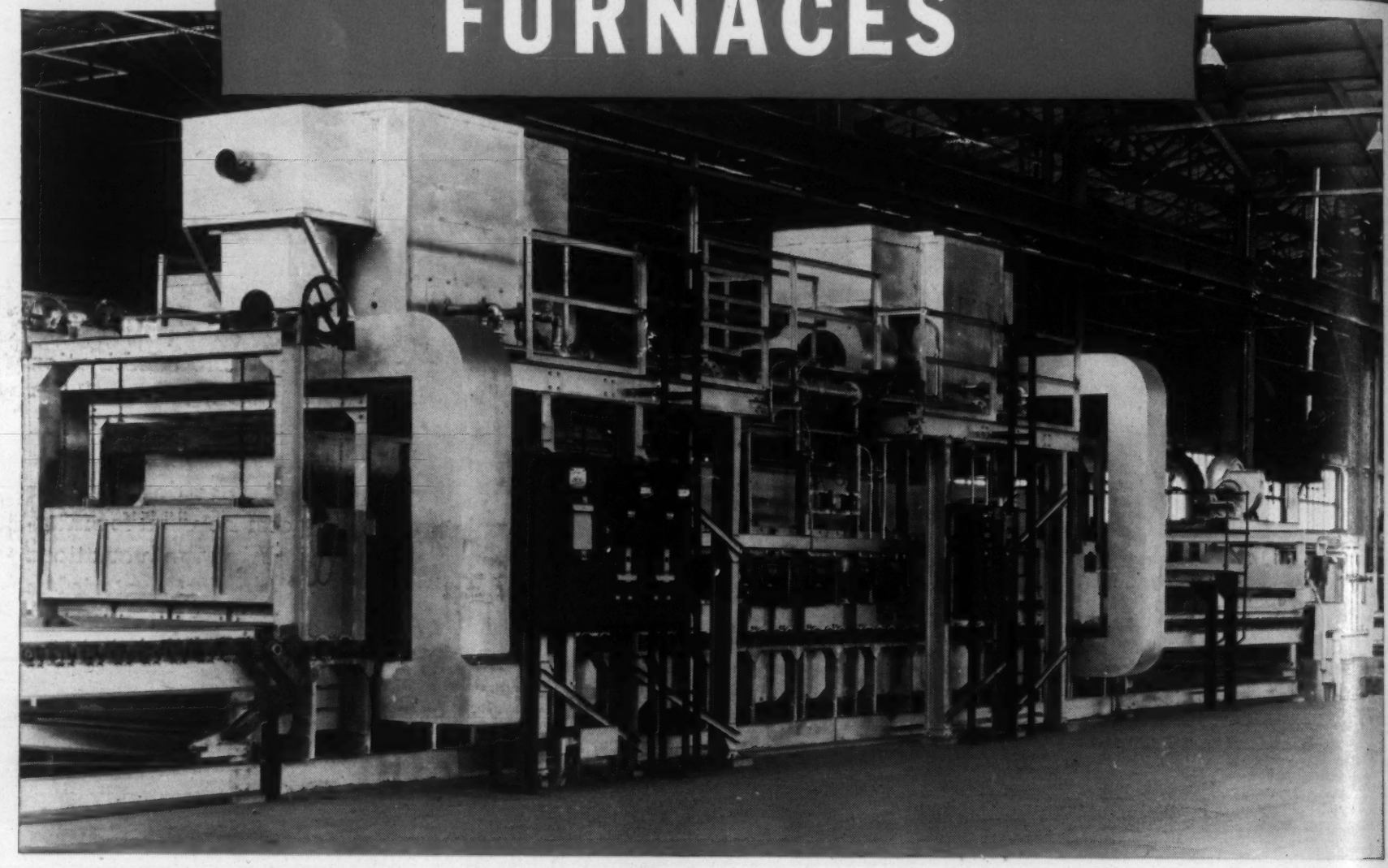
This is Number 3 of a series of statements on how to use Dowmetal Magnesium Alloys in designing diverse products. They cover technical information on the standard forms of fabrication, as well as tables on properties and the characteristics of the various alloys. All this material is available in an illustrated booklet. A copy will be mailed you on request.

**MAGNESIUM DIVISION • THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN**

New York • Boston • Philadelphia • Washington • Cleveland • Detroit • Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle

# DREVER

## RECIRCULATING FURNACES



This representative Drever Continuous Recirculating furnace is especially adaptable for treating a wide variety of materials—sheets, plates, or miscellaneous shaped parts.

Completely equipped with all control and safety devices, Drever gas or oil fired recirculating furnaces afford rapid heating for temperatures of 1250° or below. The material is conveyed through the furnace on the rolls themselves or in containers. These furnaces may be inserted in a production line or used as separate units.

We would be glad to discuss with you the inherent advantages of this equipment which is designed in any required size to meet individual needs.

*EXPERIENCE POINTS TO* THE DREVER CO.

THE DREVER CO.

750 E. VENANGO ST., PHILADELPHIA 34, PA.

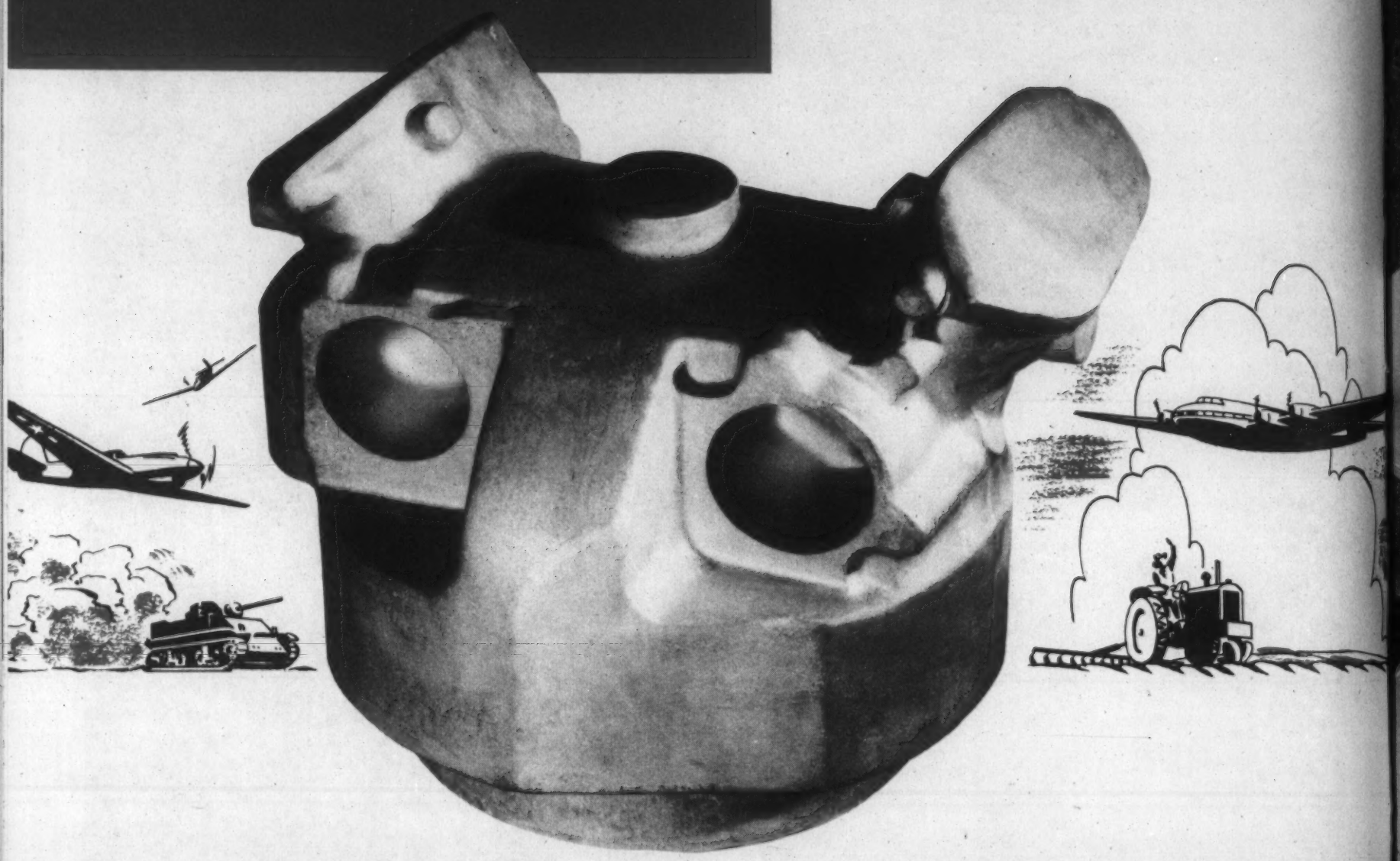
# Torpedo Squadron 8

BY JAMES M. SESSIONS

NO. 6 OF A SERIES "HIGHLIGHTS OF WORLD WAR II" PRESENTED BY TUBE TURNS (INC.) LOUISVILLE, KY. SEE OTHER SIDE

# Challenge

## to peacetime "can'ts"

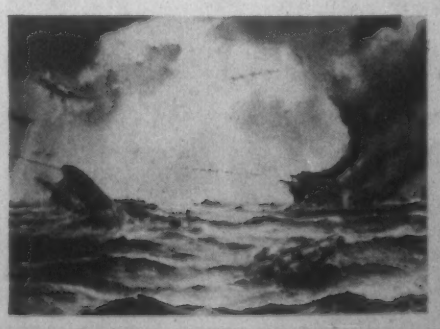


A forging as large and complex as this one requires the largest upsetter ever made.

The trend toward larger upset forgings and the use of lighter metals was recognized by Tube Turns even before Pearl Harbor. With an eye to new industrial advancements, a battery of these mammoth nine-inch upsetters was ordered; later many power presses, heat treating furnaces and special machines were added to this formidable array of forging equipment.

The pressure and exigencies of war forced the development and use of these facilities far beyond the probable need of normal industrial progress. Thus the skill accumulated during *wartime* operation will be added to the value of Tube Turns' farsighted *prewar* thinking, and the benefits will be reaped by industry when peace comes. Tube Turns, Inc., Louisville 1, Ky.

**TUBE TURNS** *Forgings for Industry*



*Commemorating the epic sacrifice made by Torpedo Squadron 8 in the Battle of Midway (see reverse side) is Sessions' 6th in a series of 12 dramatic war paintings presented by Tube Turns.*

*For tomorrow - new economy and efficiency with*

**SuVeneer*** CLAD METAL

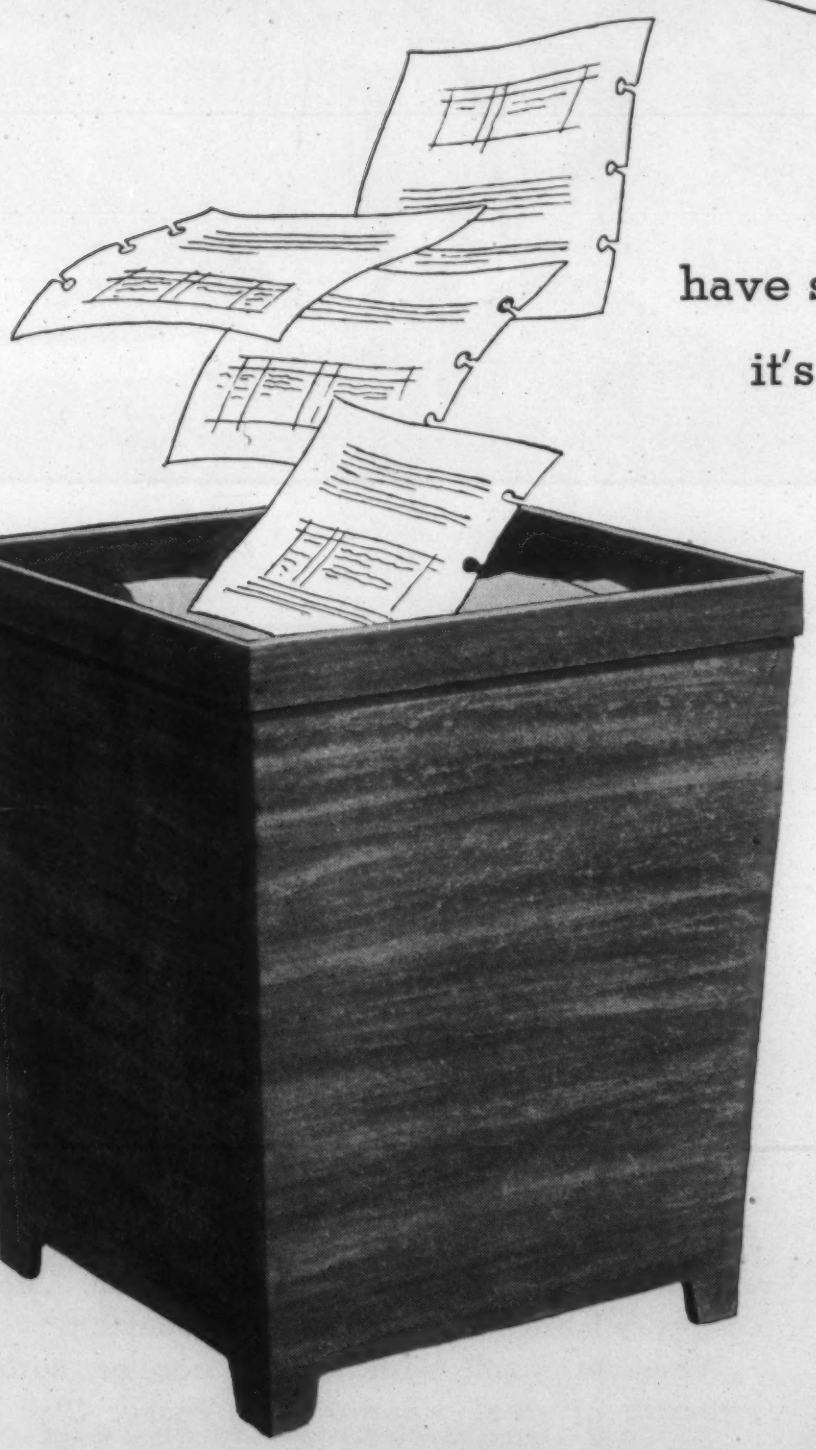
* Trademark Reg. U. S. Pat. Off.

Mass housing requirements after Victory will be met by plans laid now—planning shared by designers in scores of different fields. For electrical products, SuVeneer Clad Metal in its form of *copper* inseparably bonded to steel, offers the important new advantage of copper's conductivity *plus* a strong backbone of steel . . . and low cost, easy fabrication, complete dependability.

Wherever you'll wish to use *copper with the strength of steel,* war-proved SuVeneer Clad Metal invites your interest—now!

**Superior Steel**
CORPORATION
CARNEGIE · PENNSYLVANIA

# Throw away the old tables of heat penetration!



## New GAS techniques have speeded heat input unbelievably . . . it's a revolution in industrial heating

Once it was taken for granted that heat penetration of metals must take just so much time—say, a heating rate of one inch per hour, or some such figure. But today many conventional practices and old established principles of heat-treatment are obsolete. The speeded heat input of modern Gas equipment is so sensational as to constitute a revolution in industrial heating.

Under the pressure of war, ¼-inch wall steel tubing is being fully annealed 4 inches from the top down in two minutes. Six-inch steel billets are being heated to forging temperatures in 15 minutes, three times faster than was possible before. Stainless steel tubing 1/16 inch thick is being fully annealed in five seconds. All these and many more operations with modern Gas equipment.

These new and shorter heating cycles—permitting different methods of handling materials—giving greater flexibility of operation and making possible high production with small-sized units—will revise many manufacturing methods and products in the post-war era.

Ask for full information from your Gas company on how modern Gas heat-treatment is breaking many traditions. It may affect your post-war product.

***BUY WAR BONDS—HELP SPEED VICTORY!***

*American Gas Association*

INDUSTRIAL AND COMMERCIAL GAS SECTION
420 LEXINGTON AVE., NEW YORK 17, N. Y.

THE TREND IS TO GAS
FOR ALL INDUSTRIAL HEATING

Advertisement JUNE, 1944

# COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

*Prepared Each Month by the Bridgeport Brass Co.* "Bridgeport" BRASS CO. *Headquarters for BRASS, BRONZE and COPPER*

## Brazing – Joining Iron or Steel with a Copper-Base Alloy Bond

Another outstanding characteristic of Brass is its ability to act as a bonding material. It is only necessary to bring the clean base metal, iron or steel, to a good red heat for adhesion to take place with the molten brass. In practice "brazing" is carried out without melting the edges of the base metal to be joined. These edges are heated to a point where the molten metal from the brass welding rod spreads thinly over the heated surface with the aid of melted flux. When solidified, the brazing alloy will have adhered to the base metal. More brazing alloy is melted, building up to the thickness desired.

The term "brazing" has in many cases been replaced by "bronze welding" because the brazing alloys often contain small amounts of tin and are called "bronzes" rather than "tin-brasses." In true or "autogenous" welding, however, both the base metal and the welding rod must be heated to fusion.

Since brazing requires only local preheating of the base metal to a dull or cherry-red, warping, cracking and expensive preheating with charcoal or torch followed by slow cooling can be avoided. Often brazed joints can be made without dismantling the equipment, thus saving considerable time and labor. When properly made, the brazed joints are often stronger than the base metal itself.

The application of brazing or bronze welding for repairing cast iron and steel parts, for building up wearing surfaces, and as a modern method of fabrication, has grown tremendously because of the great savings effected in machinery and equipment which previously had to be thrown to the scrap pile. The metals which can be bronze welded have equal or higher melting points than bronze welding rod, and include steel, cast iron, malleable iron, wrought iron, galvanized iron, copper, Monel, nickel and brasses with higher copper content.

Bronze welding makes possible the building up of wearing surfaces on pistons, shafts, bushings, as well as broken or worn gear teeth, and stripped threads. The deposited bronze can be readily machined and presents a wearing surface which may be tougher than the original metal. Bronze welding has been accepted as standard practice in automobile and locomotive repairing, shipbuilding, piping, steam fitting, metal working, and maintenance.

Special precautions are taken at Bridgeport to produce free flowing metals which make strong dependable bonds. The development and manufacture of reliable welding alloys are the result of constant research and laboratory control. Special compositions and processing are used in the manufacture of bronze welding alloys. Listed below are standard bronze welding alloys developed by Bridgeport:

*Bridgeport No. 192 Bronze—Low Fuming**—For gas welding and brazing—degasified and deoxidized—a two-in-one rod most highly recommended for general all around welding work. It has a low melting point, flows freely and possesses a very good tinning action. Produces a sound, non-porous, tough, yet ductile weld deposit of high tensile strength. Machines nicely. Excellent for general repairing and for building up worn surfaces where good strength and low coefficient of friction are required.

*Bridgeport Bronze*—For gas welding and brazing—fuses readily at low welding temperatures and has good tinning action. Most satisfactory for general oxyacetylene welding because it produces high strength ductile welds. Machines easily. Excellent for uniting cast iron and steel parts. It is generally unnecessary to pre-heat or dismantle equipment—heating surface only to a dull red is sufficient. Recommended for general repairing, welding automobile engine blocks, locomotive cylinders, cast iron pipes, etc.

*Bridgeport No. 1232 Silicon Bronze*—For gas or arc welding and brazing—a high strength, high copper silicon bronze that welds exceptionally well, flowing freely, making a good clean weld. Especially recommended for welding silicon bronze or copper silicon alloy sheets in the manufacture of range boilers, storage tanks, and automatic heaters. Recommended for welding Duronze II sheet or other silicon bronze alloys.

*Bridgeport Manganese Bronze (Navy)*—For gas welding and brazing—great strength combined with good ductility; flows easily; has a relatively low melting point and good tinning action. Excellent for general work where strength and toughness are required. Highly recommended for all around uses such as general repairing of cast iron and steel castings, broken gear teeth, pistons, shafts, and building up work surfaces.

*Bridgeport Naval Brass*—For gas welding and brazing—a strong bronze alloy which melts at a comparatively low temperature. Flows freely—producing a clean dense tough weld. Possesses good machining and wearing properties.

*Mfg. Under U.S. Pats. RE 17,631 and 1,525,058.

An electric brass melting furnace takes its own medicine by being brazed with "Bridgeport" bronze welding rod. Bronze welding deserves a Navy "E" for the service it renders to industry engaged in vital war work.

## CORROSION INHIBITORS

*This article is one of a series of discussions by C. L. Bulow, research chemist at the Bridgeport Brass Company*

In our discussion we have dealt with the many practical results obtained by using inhibitors in corrosive solutions. The next step is to consider the effect of modifying alloys by the addition of small amounts of metals and observing their effect on corrosion resistance.

### Salts of Arsenic and Antimony as Inhibitors

In 1908 A. S. Dwight reported that arsenic trioxide was an effective corrosion inhibitor (protected steel jackets) when added to cooling water contaminated by sulphuric acid from smelter fumes. O. P. Watts and S. G. Clarke and others have reported on the effectiveness of arsenic and antimony compounds as corrosion inhibitors. In 1924, G. D. Bengough and R. May described an experiment pertaining to the effect of arsenic trioxide as an inhibitor of copper deposition on 70-30 brass in cupric chloride solution. Their experiment consisted of suspending pieces of condenser tubing in beakers containing 150 cc cupric chloride solution and known amounts of arsenic trioxide. It was found that arsenic was effective in preventing the deposition of copper when the ratio of the concentration of arsenic to copper in the solution was approximately 1 or more. They concluded that "In view of the remarkable effect of arsenic in influencing the nature of the corrosion products of brass, and through them the corrosion rate of the alloy itself, it was decided to examine the influence of a number of metals which commonly occur in brass, either as accidental or intentional additions."

### Effect of Alloying Elements on Dezincification of Brass

When G. D. Bengough and R. May discovered that a few thousands of a per cent of arsenic added to 70-30 brass alloy inhibited dezincification, they experimented with other modifications of 70-30 brasses. They found that the addition of tin, nickel, aluminum, tungsten, manganese or iron all had varying influences on rate of dezincification. Their work showed that otherwise pure 70-30 brass containing as little as .02% arsenic would not dezincify; that is, the arsenic would prevent "copper deposition in the heart of the metal in any conditions likely to occur in sea water up to a temperature of at least 50°C and that even .01% arsenic may be effective." The addition of .02% arsenic to 70-30 brass as a dezincification inhibitor was reported as being more effective than 1% tin.

The order of the elements preventing dezincification was as follows: arsenic, tin, nickel, tungsten and aluminum. Manganese and iron, however, increased the rate of dezincification under these conditions. In the same year (1924) C. F. Nixon reported that brass containing less than .3% of arsenic was remarkably resistant to dezincification.

More recently F. W. Fink, F. M. Barry, W. Lynes, J. H. Hollomon and John Wulff have reported on the effectiveness of arsenic as a dezincification inhibitor. It was also learned that other elements in Group 5 of the periodic table, namely, phosphorus and antimony, are also effective inhibitors.

F. M. Barry reported the results of a total immersion test conducted in 1% cupric chloride solution. The effect of the dezincification inhibitors, arsenic, antimony and phosphorus, at 80°F. was very marked when compared to regular Admiralty metal. All three inhibitors had about the same effect. However, it was reported that the arsenic inhibited alloy was not as effective as the antimony or phosphorus at 125°F. due to a peculiar intercrystalline corrosion which appeared in the arsenical Admiralty.

Subsequent work by W. Lynes on the same inhibitors in 70-30 brass and Admiralty metal failed to reveal any such variation in the behavior of the arsenical Admiralty metal when tested in a 5% cupric chloride solution containing 5% hydrochloric acid. "Conditions were established in the laboratory that resulted in complete dezincification of .0350" diameter plain 70-30 brass and Admiralty metal rod in a period of 10 weeks. Under these conditions, the same alloys modified by about 0.03% arsenic, antimony or phosphorus did not dezincify; neither did corrosion of the modified alloys progress along grain boundaries."

### Arsenical Admiralty Standard Condenser Tube Alloy

The use of arsenic as an inhibitor in Admiralty Condenser Tubes has been standard practice with Bridgeport Brass Company for a number of years.

Experience in service covering many millions of pounds of arsenical Admiralty condenser tubing has failed to reveal a single instance of the intercrystalline attack. It must be borne in mind that laboratory corrosion tests with cupric chloride solutions are frequently useful as an exploratory procedure, nevertheless actual service experience over a long period of time is the final judge of the best material. In a later article we will discuss the results of tests made in various waters.

## NEW DEVELOPMENTS

*This column lists items manufactured or developed by many different sources. None of these items has been tested or is endorsed by the Bridgeport Brass Company. We will gladly refer readers to the manufacturer or other sources for further information.*

**A Hydrostatic Test Press** has been developed for determining drawing qualities of metals, fatigue in metals and alloys and influence of heat treatment. Coatings for metals such as paint, enamel and plastic can be tested by alternate applications of pressure, simulating expansion and contraction. The clamping portion of the press makes it possible to test items of varying heights without retooling. External pressure may be employed to determine the strength of all types of containers. This press can be built in various sizes and capacities to suit particular requirements. **(No. 562)**

**Copper Oxide Rectifiers** are now available in a wide range of sizes for industrial and commercial equipment applications. These newly developed copper oxide rectifiers feature gold contacts on copper oxide pellets, highly adaptable mountings, pre-soldered lead wires and other arrangements to prevent overheating during assembly of equipment using these units. **(No. 563)**

**Integral Insulating Sleeve** in new diamond grip connector is crimped in available press dies to bond the copper terminal to the conductor of a wire slipped into position. The crimping operation also compresses the sleeve on the insulation of the conductor to serve as support. Material in sleeve resists distortion and cracking, does not support combustion, has dry dielectric strength of 750 vpm. **(No. 564)**

**A New Arc Welder** rated at 200 amperes, and light in weight, has a new "shield-arc" engine driven welder with rugged construction and a powerful enclosed mounted engine of 29 horsepower. This new unit, supplied complete with base and canopy, has a current range of 40 to 250 amperes. Dual control of welding current is accomplished by adjustment of series fields and generator speed. Designed for metallic arc welding, with bare or coated electrodes, this new model also supplies uniform welding current for carbon-arc welding. **(No. 565)**


## PRODUCTS OF THE BRIDGEPORT BRASS COMPANY

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**SHEETS, ROLLS, STRIPS**—*Brass, bronze, copper, Duronze*, for stamping, deep drawing, forming and spinning.

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**PHONO-ELECTRIC* ALLOYS**—High-strength bronze trolley, messenger wire and cable.

**WELDING ROD**—For repairing cast iron and steel, fabricating silicon bronze tanks.

**LEDRITE* ROD**—For making automatic screw machine products.

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*Established 1865*

**BRASS, BRONZE, DURONZE WIRE**—For cap and machine screws, wood screws, rivets, bolts, nuts.

**DURONZE ALLOYS**—High-strength silicon bronzes for corrosion-resistant connectors, marine hardware; *hot rolled sheets* for tanks, boilers, heaters, flues, ducts, flashings.

**COPPER WATER TUBE.**

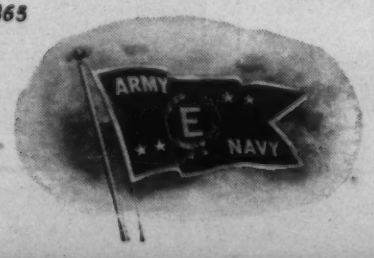
**FABRICATING SERVICE DEPT.**—Engineering staff.

**BRASS AND COPPER PIPE.**

*Note: Bridgeport products are supplied in accordance with existing priority regulations.*

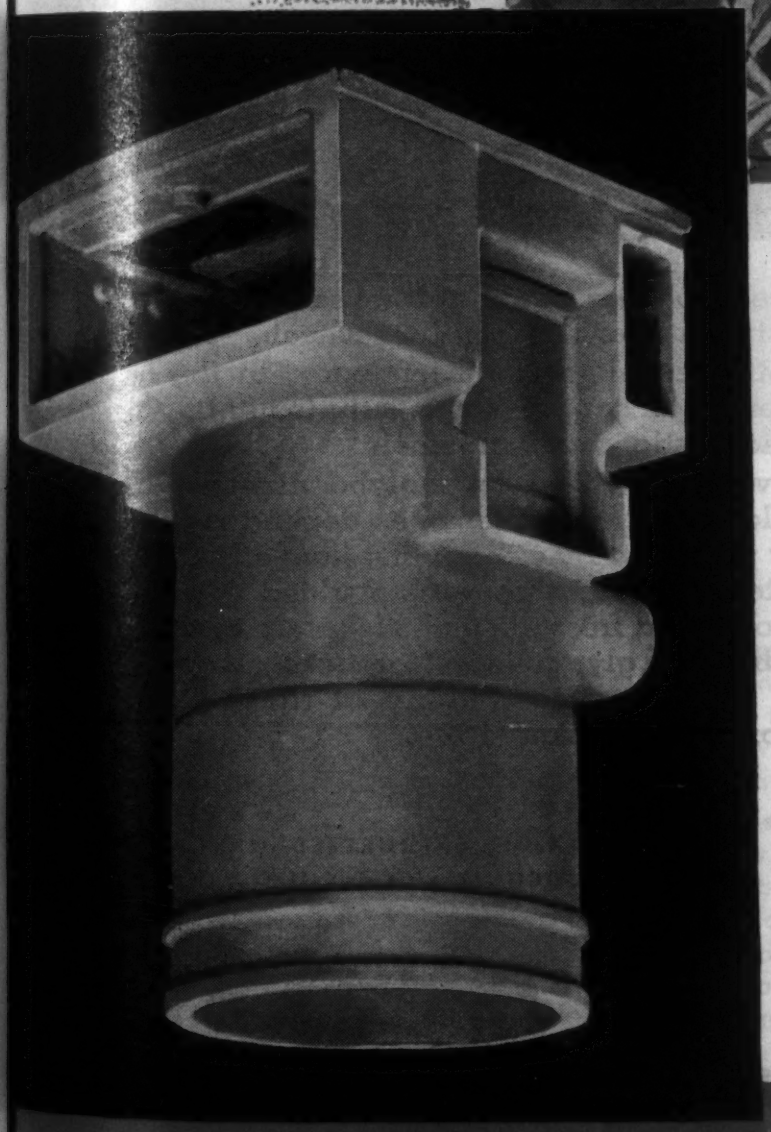
*Trade name.

BRIDGEPORT BRASS



Aerial cameraman readying a Fairchild Camera for use from the air. Note camera is covered by electrically heated leather jacket to protect it from the severe weather encountered.

# THIS FAIRCHILD AERIAL CAMERA *10 pounds lighter* Because of HILLS-McCANNA DOWMETAL MAGNESIUM ALLOY SAND CASTINGS



The Casting shown is for an automatic reconnaissance aerial camera. It weighs only 12.3 pounds before machining.

RECONNAISSANCE planes, whose job it is to help secure aerial photographs of enemy movements and territory, are given *extra* altitude by any weight-savings in equipment carried.

The designers of Fairchild Aerial Cameras contribute toward this weight saving by utilizing Hills-McCanna Magnesium Alloy Sand Casting in the removable roll film magazine and the central portion of the camera lens cone.

The remarkable lightness of magnesium metal combined with exceptional strength and durability may offer just the thing you need in your post-war products. Let us discuss your projected peace time plans and products.

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PROPORTIONING PUMPS · AIR & WATER VALVES · CHEMICAL VALVES
MARINE VALVES · FORCE-FEED LUBRICATORS · DOWMETAL CASTINGS

The loss of recoverable alloys in steel scrap has been a major problem confronting the various conservation agencies. Proper segregation of scrap is one effective answer.

Segregation of scrap at the source is comparatively simple. The difficulty comes in preventing mix-ups in subsequent handlings. They can be prevented or remedied by applying two simple tests—spark and spot.

The presence of molybdenum, or nickel, or both, is readily detected by spark testing. Molybdenum causes an easily recognized secondary burst at the end of the spark stream resembling a spearpoint. Nickel produces a spot of intensely white light in the stream near the grinding wheel.

Both elements have a tendency, in the higher contents, to suppress the supplemental bursts characteristic of carbon steels.

Several spot tests for molybdenum have been developed. The simpler ones depend on the red color produced by either potassium ethyl xanthogenate or sodium thiocyanate added to a molybdate obtained from the etched surface of the steel. The dimethyl glyoxime test for nickel also depends on a red coloration. Many of these tests are approximately quantitative.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.

ARMY E NAVY

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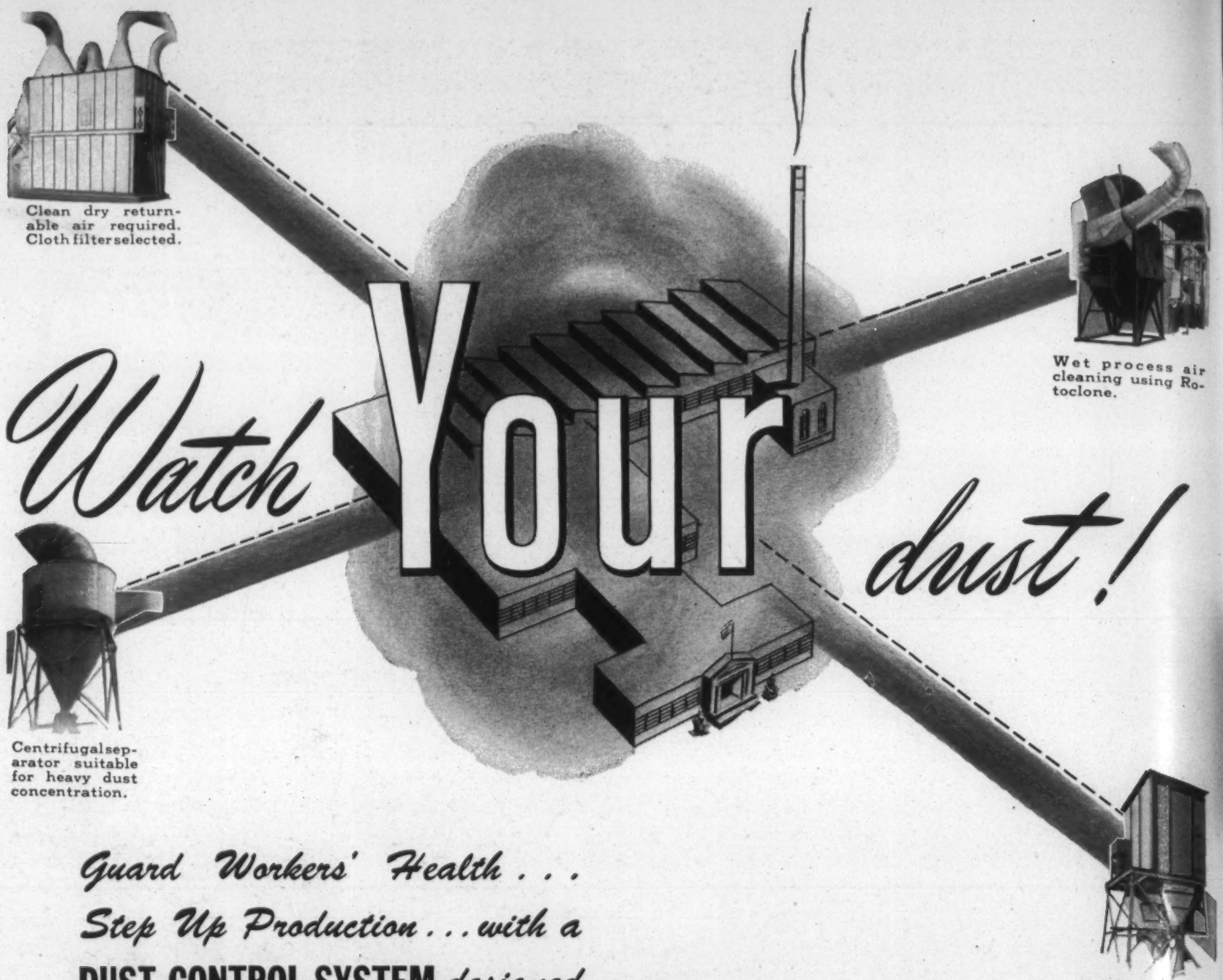
Brass forgings are made under tremendous pressure, producing a fine-grained crystaline structure. They are leak and seep-proof, thus making them essential in the handling of liquids of low specific gravity, such as gasoline, butane, or other refrigerant gases.

Forged parts can be prepared for plating with at least one less polishing operation. Physical properties are practically equal to steel without the disadvantage of rusting. Since forgings are made in dies, they can be held to very close tolerances, therefore less machining and less material to remove. High tensile strength permits the use of lighter parts—reduces metal costs. The even consistency of metal composition and absence of scale prolongs the life of machine tools.

We furnish forgings in various metal compositions of brass and bronze, nickel-silver and copper, machined or plain and in various finishes, natural or dipped, electro tinned, chrome or nickel plated. Send us blueprints or samples.

**MUELLER**
**BRASS CO.**
PORT HURON, MICH.




Clean dry returnable air required. Cloth filter selected.

Wet process air cleaning using Roto-clone.

Centrifugal separator suitable for heavy dust concentration.

Combination of centrifugal separator and dry filter.

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**DUST CONTROL SYSTEM** *designed*
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Dust control systems designed and installed by Kirk & Blum are backed by 37 years of specialized engineering experience. They consist of the *right* units, wet, dry or centrifugal, carefully selected for the individual job. They safeguard workers' health, speed output, cut costs. They help maintain maximum production during the war, and equip plants to take utmost advantage of post-war opportunities.

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Here is sheet steel of unusually high and uniform ductility—and a coating that flows with the steel. Weiralead is a new, improved hot dipped product extensively used in ammunition box liners, air cleaners, automobile radiator shells, mouldings, precipitron deposit plates, meter boxes, cabinet separators, lantern parts, radio condenser shells, can spouts, conductor pipe elbows, oil filters, and automobile and truck muffler shells. Weiralead—due to the particular composition of the coating affords better and more economical soldering. The weldability of this product makes possible difficult assemblies. Its remarkably malleable coating provides good die lubrication and is an excellent base for paint, lacquer or varnish. Write for your sample of Weiralead and complete details. It may be your answer to a tough drawing problem.

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## FOR CONTROLLED-ATMOSPHERE HEAT-TREATING!

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## Stabilog* Potentiometer Controllers keep furnace temperatures on the button with continuous firing

Where heat-treating demands a constant, non-oxidizing atmosphere, at least half the battle is won if furnaces can be successfully operated under continuance firing. And *that* takes temperature control of the most exacting type . . . throttling control with unfailing automatic reset.

Foxboro's Stabilog type of controller was the first controller ever developed to give this superfine control. Throughout its many years of widespread use, its performance has never been surpassed!

Today, in controlled-atmosphere heat-treating, *Stabilog* Potentiometer Controllers provide continuous automatic control action that's proportional to slightest temperature variations. Every load change, every fluctuation in fuel supply, is instantly balanced by their close corrective action. No other controller can match their sensitivity!

Write for detailed Bulletin 194-1 on this better control for your heat-treating furnaces. **The Foxboro Company, 54 Neponset Avenue, Foxboro, Massachusetts, U. S. A.** Also Montreal, Canada. Branches in principal cities.

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When George Washington was elected President of United States for the second time, Standard Steel Works, as "Freedom Forge", started on its historic career of service to American industry. Through war emergencies and commercial depressions this company has produced quality steel products for railroads, marine service and general industry. The traditions of this 149-year-old organization give its personnel a wealth of experience and a sense of responsibility that are reflected in the quality of its products.

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**PHILLIPS "CRUCIBLE ARC"**
Electrodes for Tool and Die Steels

Twice recently, owners and operators of tool and die shops have appeared before the important Senate Military Affairs Committee and the Draft Deferment Subcommittee of the House Military Affairs Committee. They have testified that the demand for tools and dies now is at the highest level since the war began and that they are being forced to decline many orders for tooling required for essential military production.

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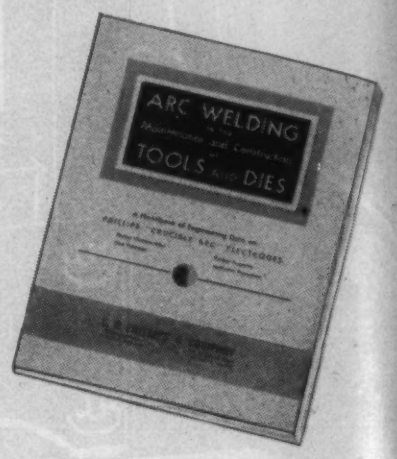


This manual contains invaluable information for your tool conservation program. Send for your copy today.

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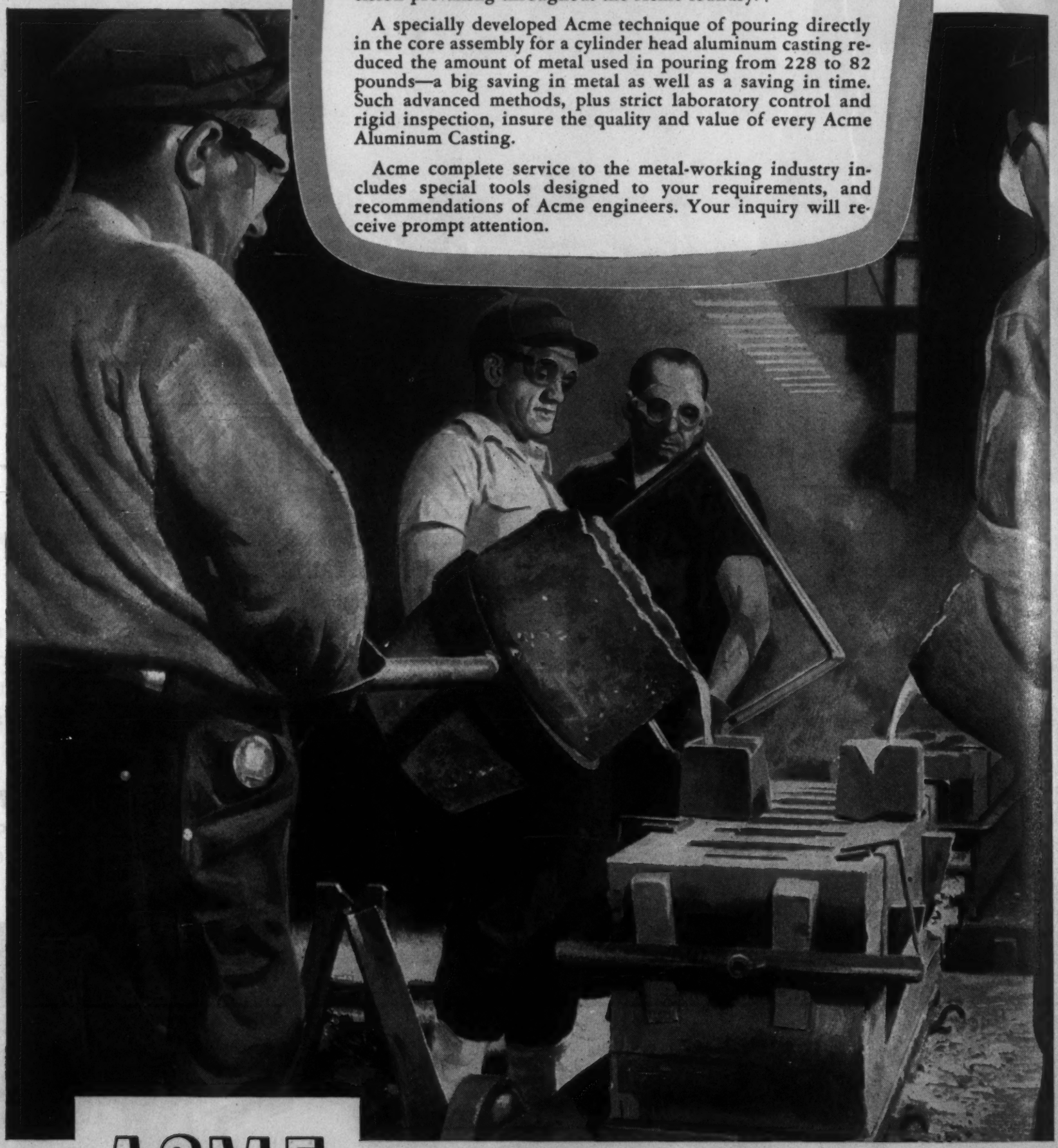
Acme complete service to the metal-working industry includes special tools designed to your requirements, and recommendations of Acme engineers. Your inquiry will receive prompt attention.



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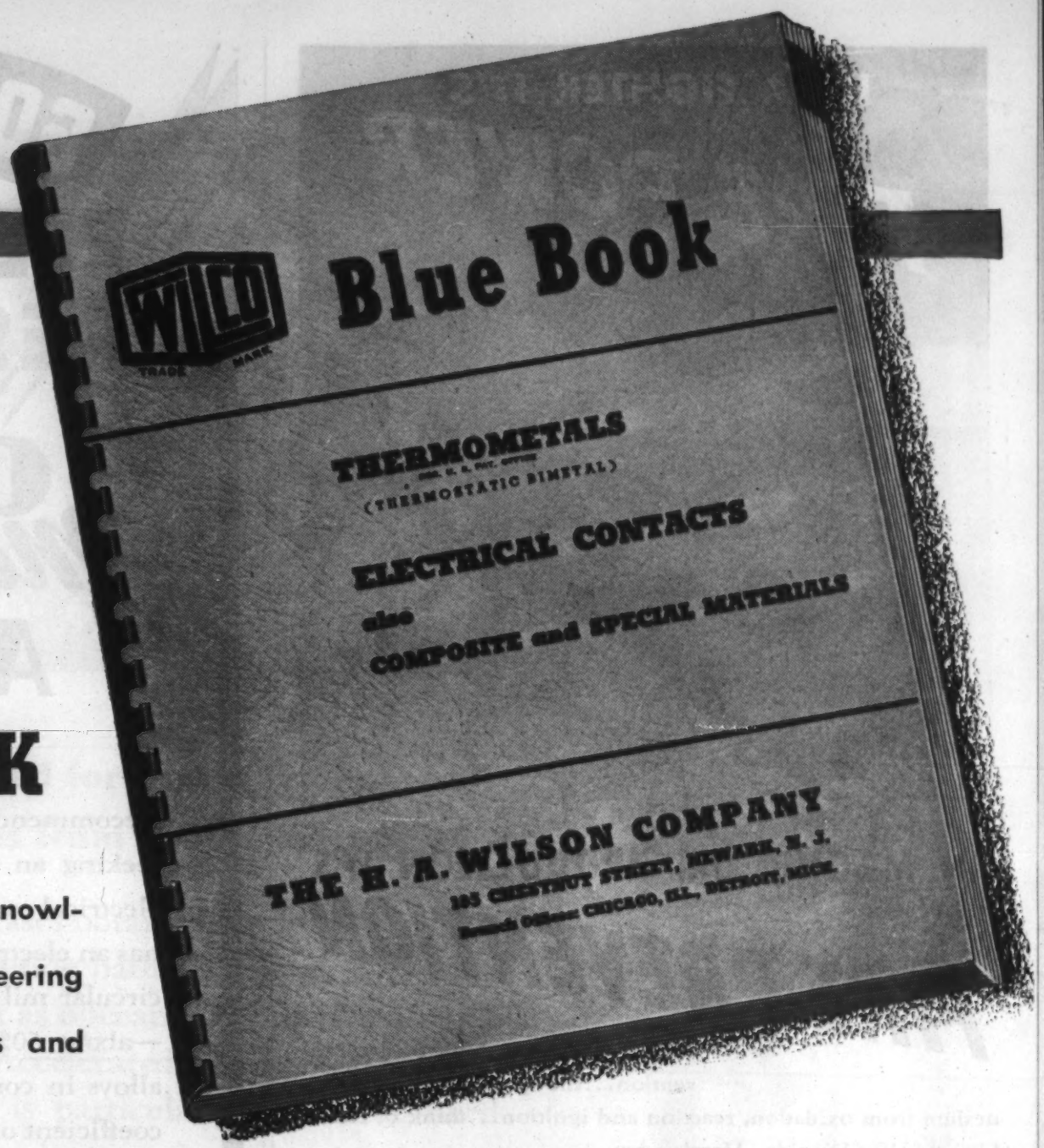


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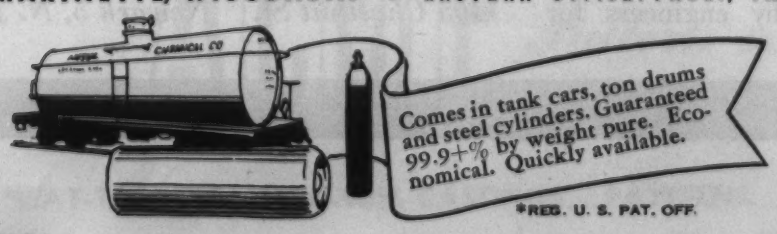


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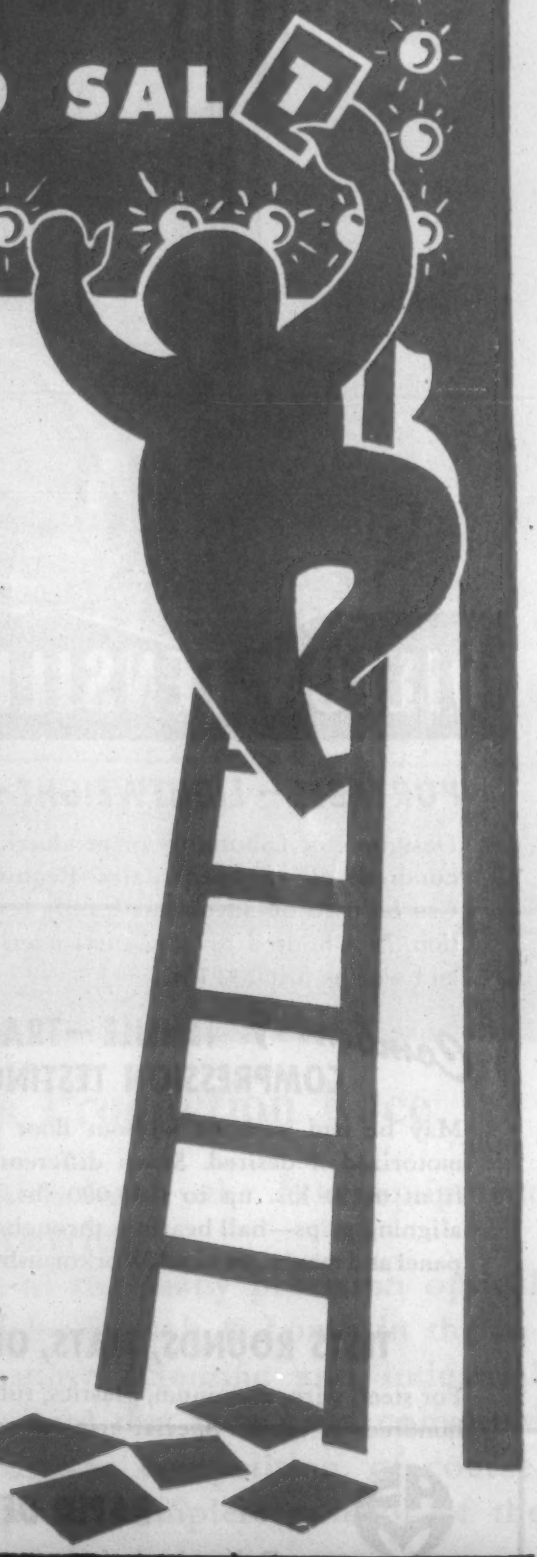


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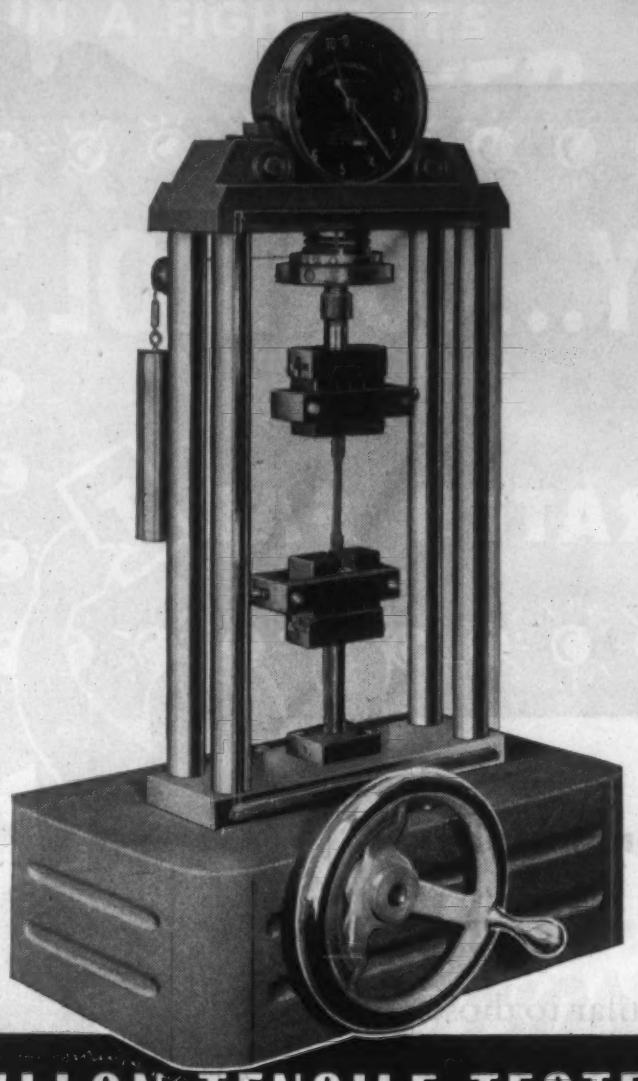

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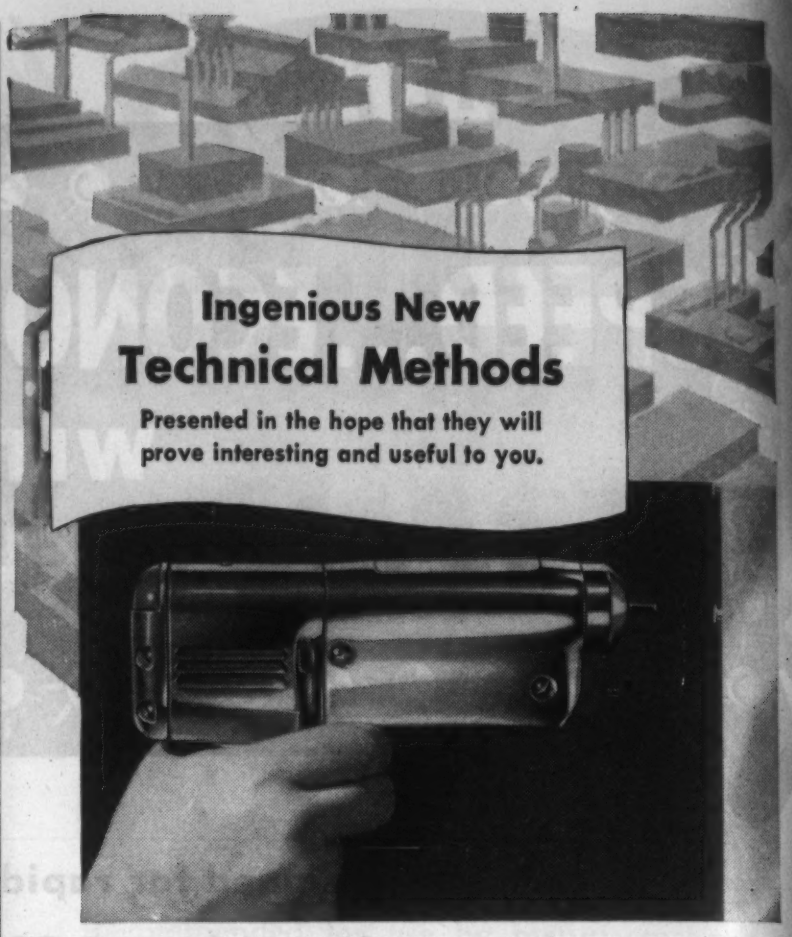


## New Air Tool Drives "blind" Rivets Accurately . . . Automatically

**Installing** "blind" RIVNUTS quickly with precise, positive upset while working entirely from one side is now possible with the recently developed Auto RIV-Driver. Completely automatic, the tool runs a threaded mandrel into a Rivnut, upsets it, backs the mandrel out and stops the tool. Operators simply press a throttle; make no manual adjustments for any operation. Rivnuts are installed 6 to 8 times faster than formerly; rejects are almost completely eliminated.

**The** tool can be adjusted to upset at any depth required. Once set, adjustment is tamper-proof —every Rivnut is driven accurately and uniformly. An indicator on the tool handle lights when the upset is correct; does not light if Rivnut is improperly headed.

**Powered** by compressed air, the Auto RIV-Driver weighs just 4¼ pounds; is 9½ inches long; balanced for efficient handling by women operators.

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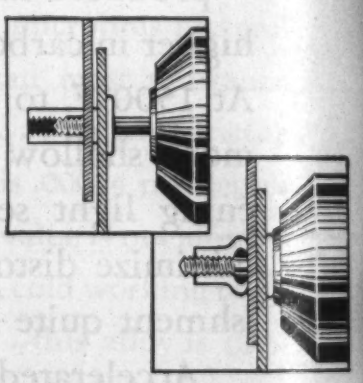
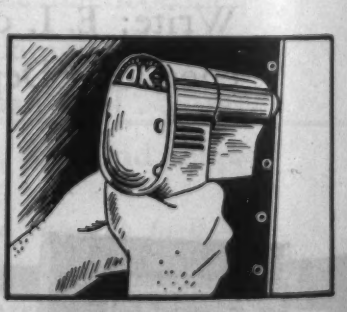
*You can get complete information from the Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago 6, Ill.*

—Adv.

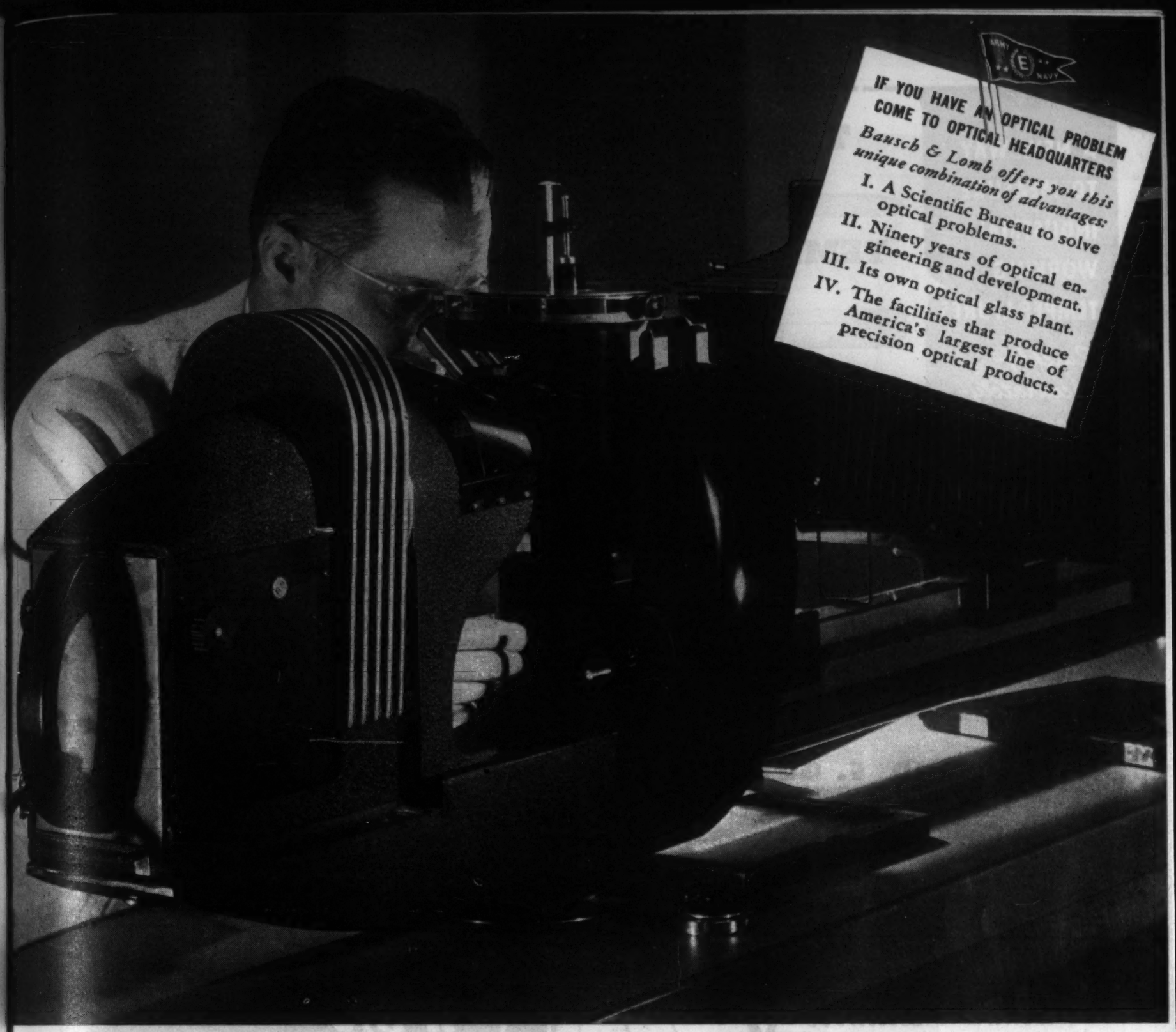


Rivnuts (mfd. by B. F. Goodrich Co.) are internally-threaded tubular rivets which can be installed "blind" while working entirely from one side of the job.




Automatic action, positive depth control and visual indicator assure correct and uniform installation of rivnuts with new Auto RIV-Driver.

Y-118

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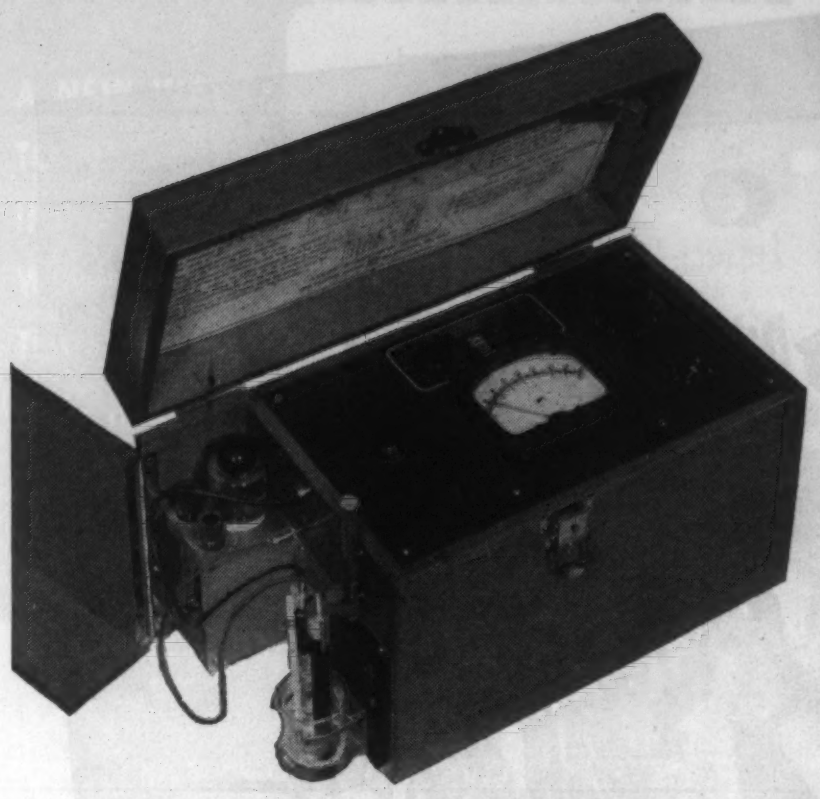

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10. Factory filled and sealed electrodes are highly stable.
11. The sample cup is a standard 50 ml beaker.
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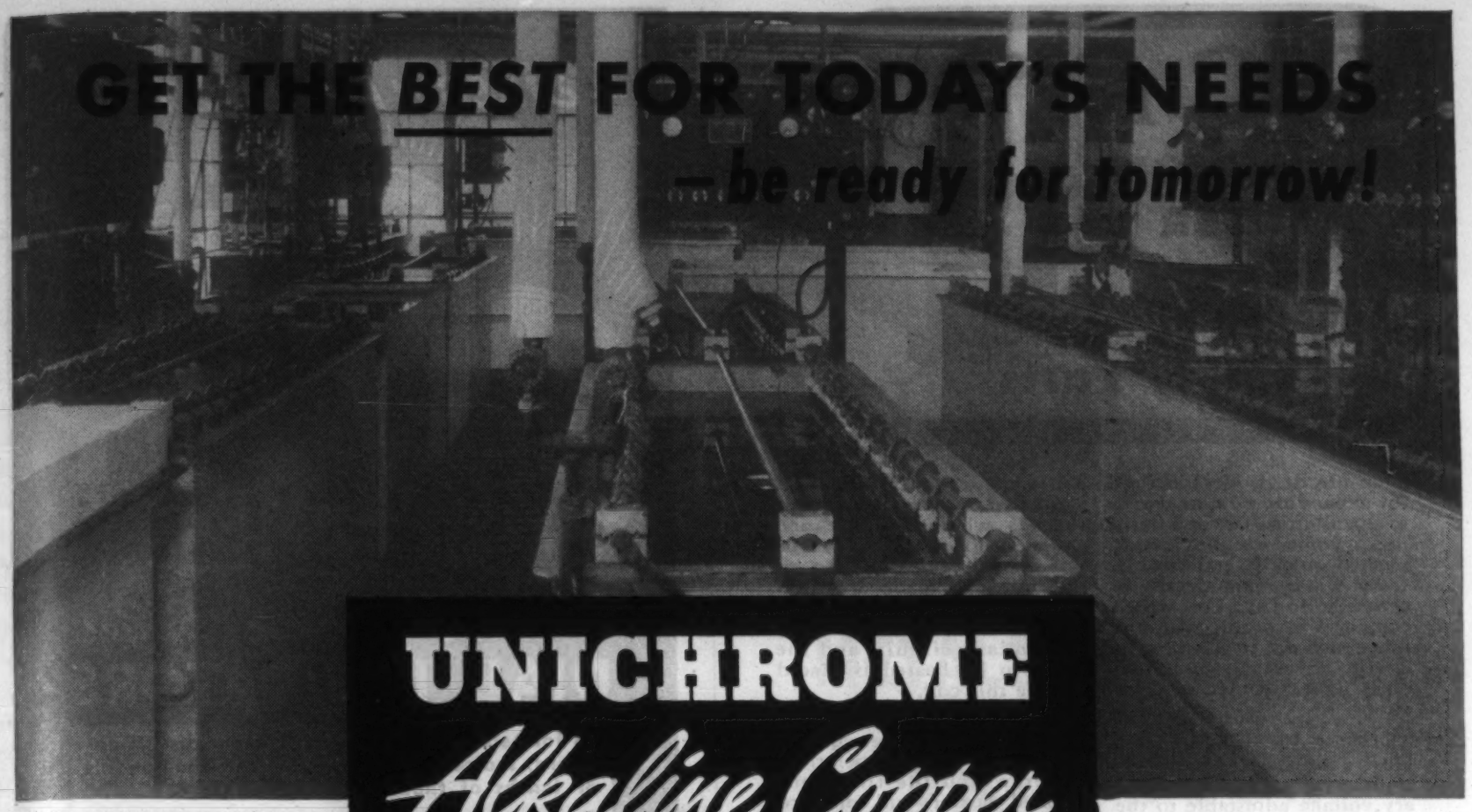


**TODAY, when it counts the most, Unichrome Alkaline Copper lends a hand to America's war-vital industries—helping set new records for speed, efficiency, smoothness of deposits and safety of operation. Tomorrow, these benefits will pay handsome dividends in the switch to *civilian application.***

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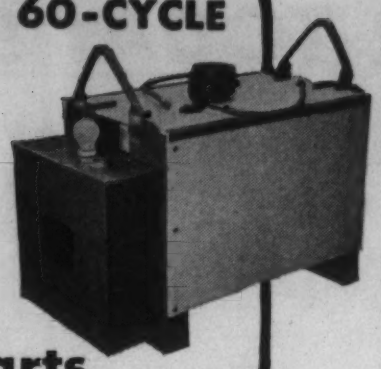
# a.c.f. 60-CYCLE INDUCTION HEATER for the heating of Machinery Parts



This affords an ideal method for expanding tubular shapes to shrink-fit collars and bushings, which can be accomplished quickly, and cleanly, with a maximum degree of accuracy, and at a cost which compares favorably with any other method. It may also be used to advantage for certain types of soft soldering operations.

The a.c.f. 60-Cycle Induction Heater consists of a stepdown transformer, with the secondary voltage adjustable to the range of work to be handled.

A temperature up to 600° F. can be attained on magnetic metals where the size and shape lends itself to this type of induction heating. An induction coil made of water-cooled tubing, closely built to the work, is connected in the secondary circuit, and the part to be heated is placed inside this coil.

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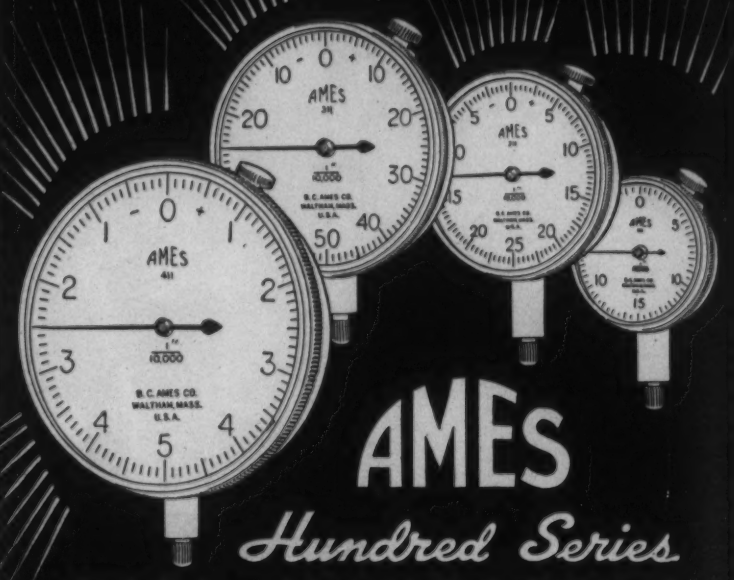


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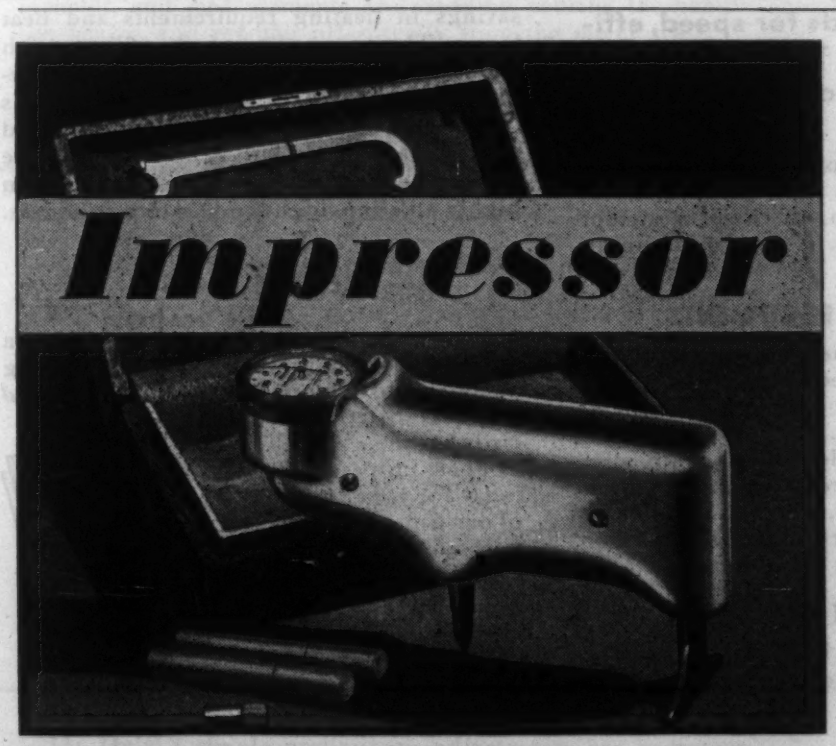

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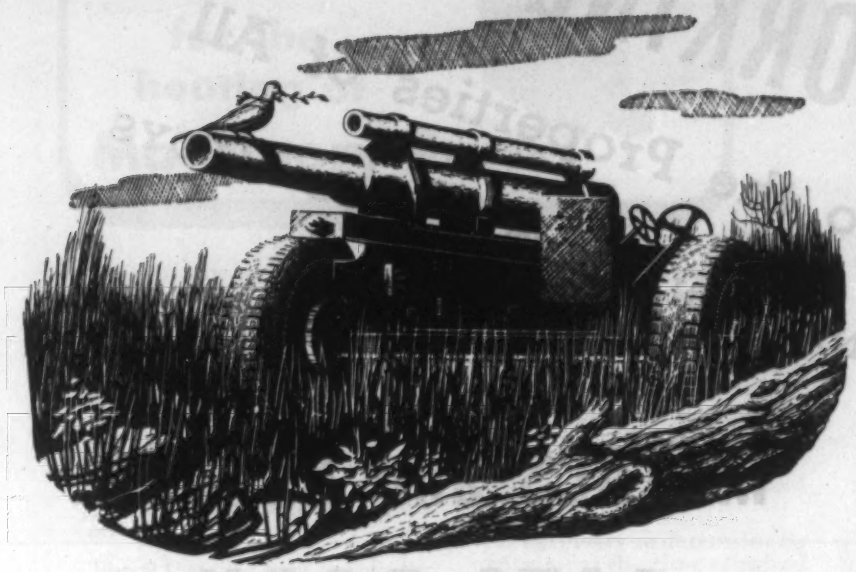

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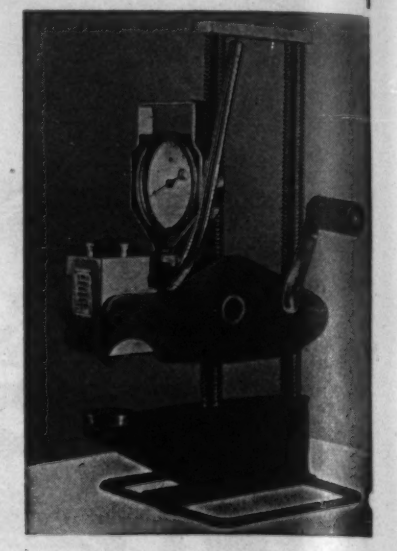

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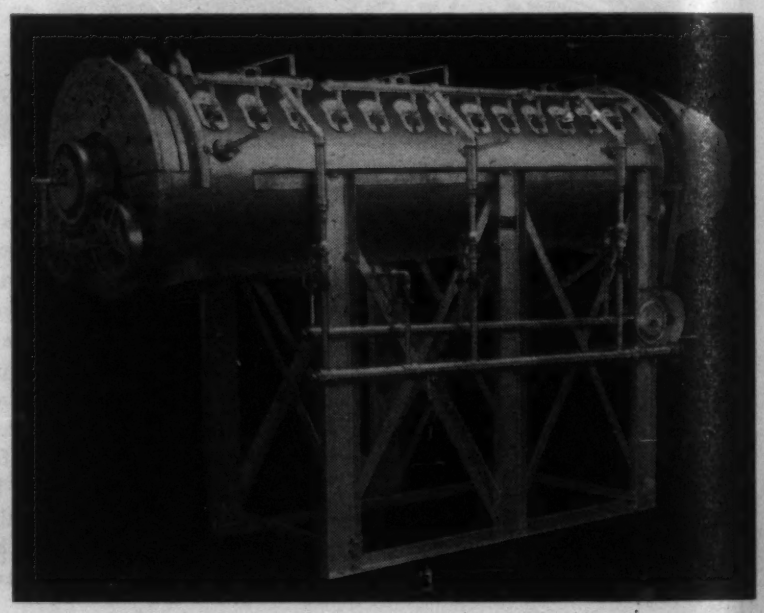

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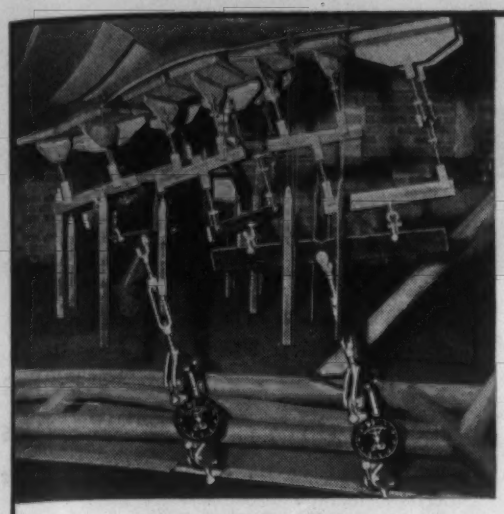

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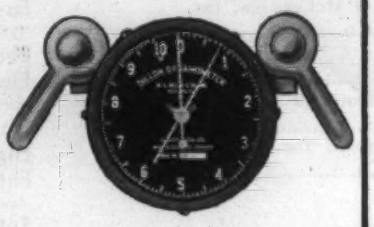

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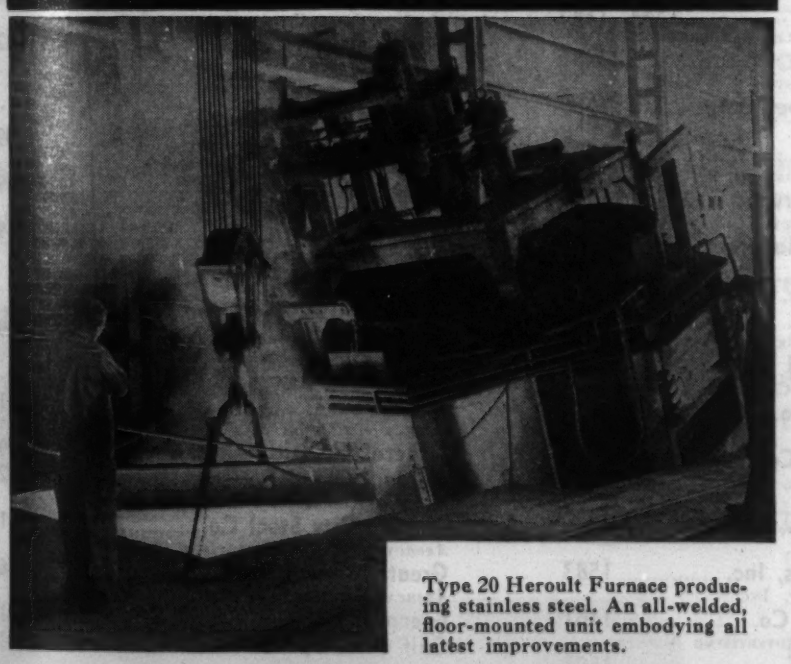

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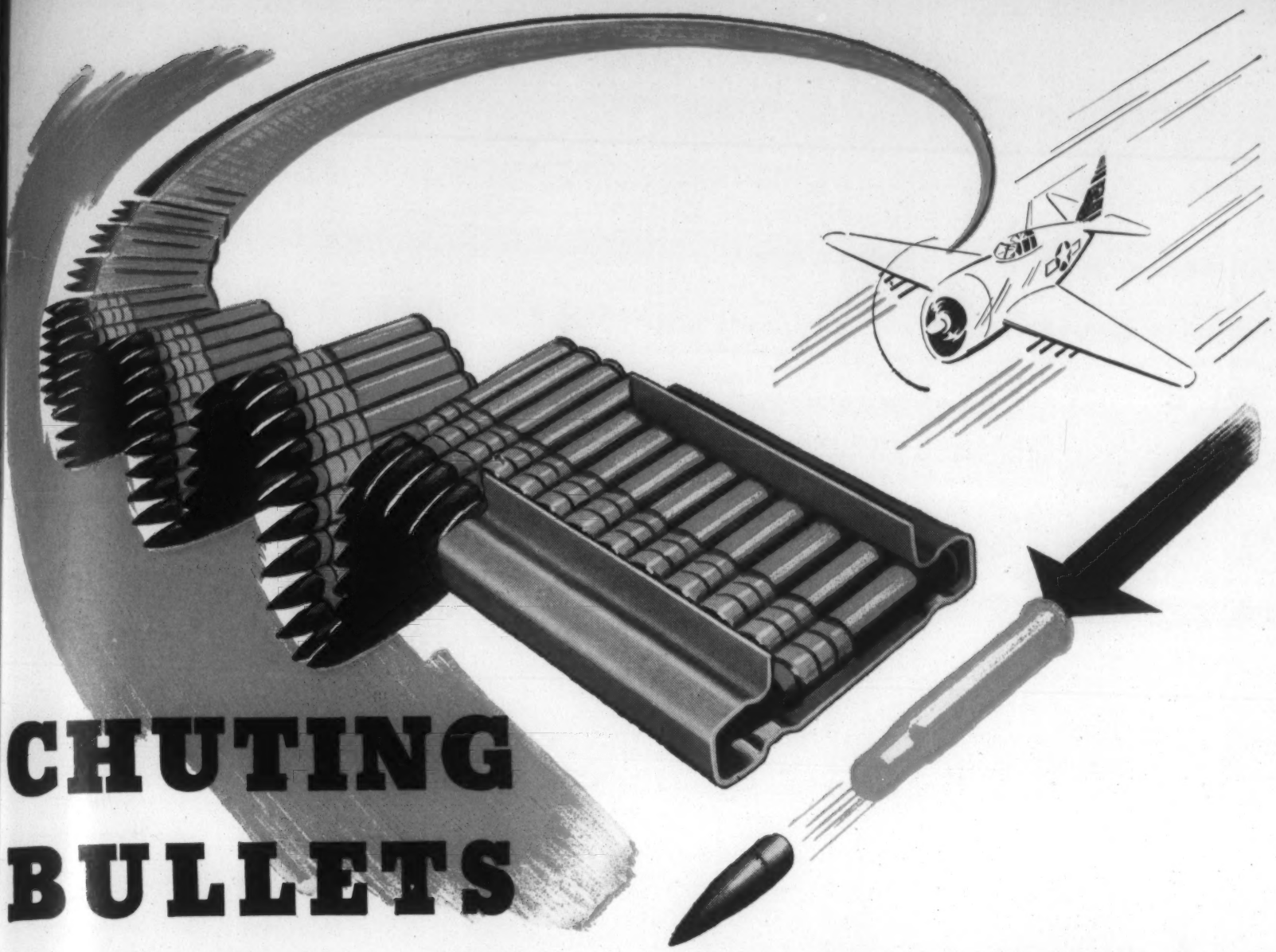

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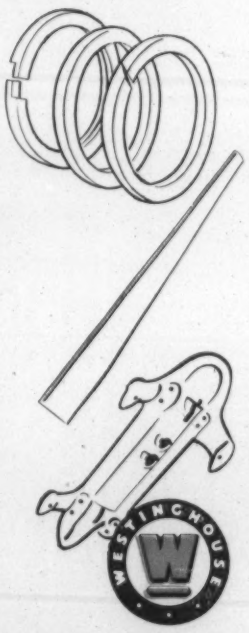


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MICARTA weighs approximately one-half as much as aluminum of equal strength—helps eliminate superfluous weight in the plane.

MICARTA rates high in flexural, compressive and impact strength. In high altitude flying, as temperatures decrease, Micarta acquires added tensile strength.

MICARTA "444" is easily and quickly produced with inexpensive wooden molds. Sheets are subjected to heat and pressure, and formed into strong, intricate shapes.

This new, Micarta "444" is now accepted for use as trim tab fairing, accumulator covers, aviator's chart cases, fuselage tail-wheel housing, wing-gun ejection chutes. For further information and your copy of the new Micarta Data Book, B-3184-A, write Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., Dept. 7-N.

J-06346-A

Westinghouse
**Micarta**
THE INDUSTRIAL PLASTIC

# WHY *Salt Baths* ARE SPECIFIED!

It is universally admitted today that no branch of metal-working has made greater progres than heat treatment. "All purpose" furnaces are unknown, but it is a fact that electric sal bath furnaces show a wider range of usefulness than any other type. . . .

That means, specifically, Ajax-Hultgren furnaces, of which more have been installed than all other electric makes combined.

Salt bath treatment is specified in all its astonishing variety, from 350° to 2400° F. because it "controls the atmosphere" by eliminating it. . . . A salt film seals out deleterious gases up to the instant of quenching, and an Ajax furnace produces more completed pieces, with fewer rejects, than any radiation or forced convection unit of the same size. . . .

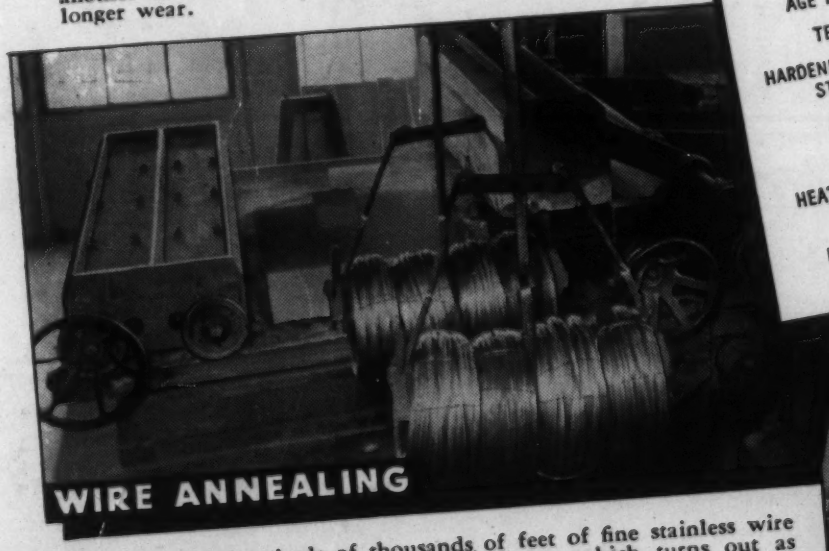
There are hundreds of applications* for which Ajax furnaces are specified. A few are shown below. Data is given in 1944 Catalog 107-B which may be had by writing: **AJAX ELECTRIC CO., Frankford Ave. at Delaware Ave., Philadelphia 23, Pa.**

Conveyorized neutral hardening bath for treating spline shafts, followed by timed quench, and quench in another salt bath (martempering). Shafts show 30% longer wear.

HERE ARE THE KEY PROCESSES TODAY...

CARBURIZING
•
SIMULTANEOUS BRAZING & CARBURIZING
•
NEUTRAL HARDENING
•
CYANIDE HARDENING
•
SELECTIVE HEATING
•
AGE HARDENING
•
TEMPERING
•
HARDENING HIGH-SPEED STEEL TOOLS
•
ANNEALING
•
BRAZING
•
HEATING FOR FORGING
•
ISOTHERMAL HEAT TREATMENT

Carburizing ordnance parts in one of the largest w plants in the East. Uniform case, freedom from distortio ability to treat selectively, are all characteristic of Ajax ts.




Process annealing hundreds of thousands of feet of fine stainless wire in the Ajax-Hultgren electric salt bath furnace which turns out as much annealed wire as 6 continuous annealing furnaces.

The world's largest electric salt bath furnace, used for heat treatment of aluminum alloy sheet, sections, and large parts. Uniformity of heating avoids distortion.

*THERE'S AN AJAX INSTALLATION NEAR YOU!

SELF-HEATING • SELF-CIRCULATING

## THE AJAX HULTGREN ELECTRIC SALT BATH FURNACE

**ASSOCIATE COMPANIES:**

AJAX METAL COMPANY, *Non-Ferrous Ingot Metal for Foundry Use*
AJAX ELECTRIC FURNACE CORPORATION, *Ajax-Wyatt Induction Furnaces for Melting*
AJAX ELECTROTHERMIC CORPORATION, *Ajax-Northrup Induction Furnaces for Melting, Heating*
AJAX ENGINEERING CORPORATION, *Ajax-Tama-Wyatt Aluminum Melting Furnaces*